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Rio Blanco Oil Shale Project

PROGRESS REPORT 8 - SUMMARY

JUNE · JULY · AUGUST, 1976

Gulf Oil Corporation
and
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PROGRESS REPORT 8 - SUMMARY

TRACT C-a OIL SHALE DEVELOPMENT

to

AREA OIL SHALE SUPERVISOR
UNITED STATES GEOLOGICAL SURVEY

31 October 1976

by

RIO BLANCO OIL SHALE PROJECT

Gulf Oil Corporation
and
Standard Oil Company (Indiana)

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INTRODUCTION

Rio Blanco Oil Shale Project (Gulf Oil Corporation and Standard Oil Company of Indiana), hereafter referred to in this report as RBOSP, is presenting its eighth summary progress report for Tract C-a to the USGS Area Oil Shale Supervisor (AOSS). This report is a summary of work accomplished during the period 1 June 1976 through 31 August 1976. The baseline data gathered for the project are on file in the Area Oil Shale Supervisor's Office in Grand Junction, Colorado. These data and its interpretive text comprise Progress Report 8. This summary report presents an overview and highlights of these data and has been correlated to and organized consistent with Progress Report 8; that is, the numbering system and topic headings for the Summary Report are the same as that used in the Progress Report. For more detailed information, the reader should refer to the Progress Report.

As has been done for Progress Reports 2 through 7, the numbering system for this report is consistent with those of the previous report. Therefore, a reader desiring information on the same subject in the previous reports (both Summary and Progress Reports) will find it under the same title heading and number. For this Progress Report, only those tasks are included for which activity was reported for the quarter. The Table of Contents for the Geotechnical Data Gathering Project lists only those programs that are still being worked; all other programs are complete. An index of all the tasks reported in previous progress reports is included in this section. The Table of Contents for the Environmental Baseline Data Gathering Project lists all the programs under investigation. Where programs indicate "no data collected", the numbers are left out of the text portion.

It should be noted that results of data taken during this quarterly reporting period but not available in time for this progress report will be included in the ensuing reports.

Additional information for the subjects covered in this progress report can be found in the following:

- Tract C-a Detailed Development Plan - March 1976
- Progress Reports 1 through 7 on file with the AOSS
- Annual Report - Tract C-a - Terrestrial Ecology Baseline Studies - March 1976
- Annual Report - Tract C-a - Aquatic Ecology Baseline Studies - March 1976

The field studies for the aquatic biology program have been completed and only a lagomorph night census remains to be completed for the terrestrial biology program. As additional baseline studies are completed, all information will be reviewed, analyzed and integrated into a final report.

For general informational purposes in this report, two figures are shown. Figure 1 is a location map of Tract C-a showing major drainages, roads, towns and counties in the vicinity of the tract. Figure 2 shows Tract C-a in greater detail and generally locates the drill holes, stream gaging stations, air quality towers and roads.

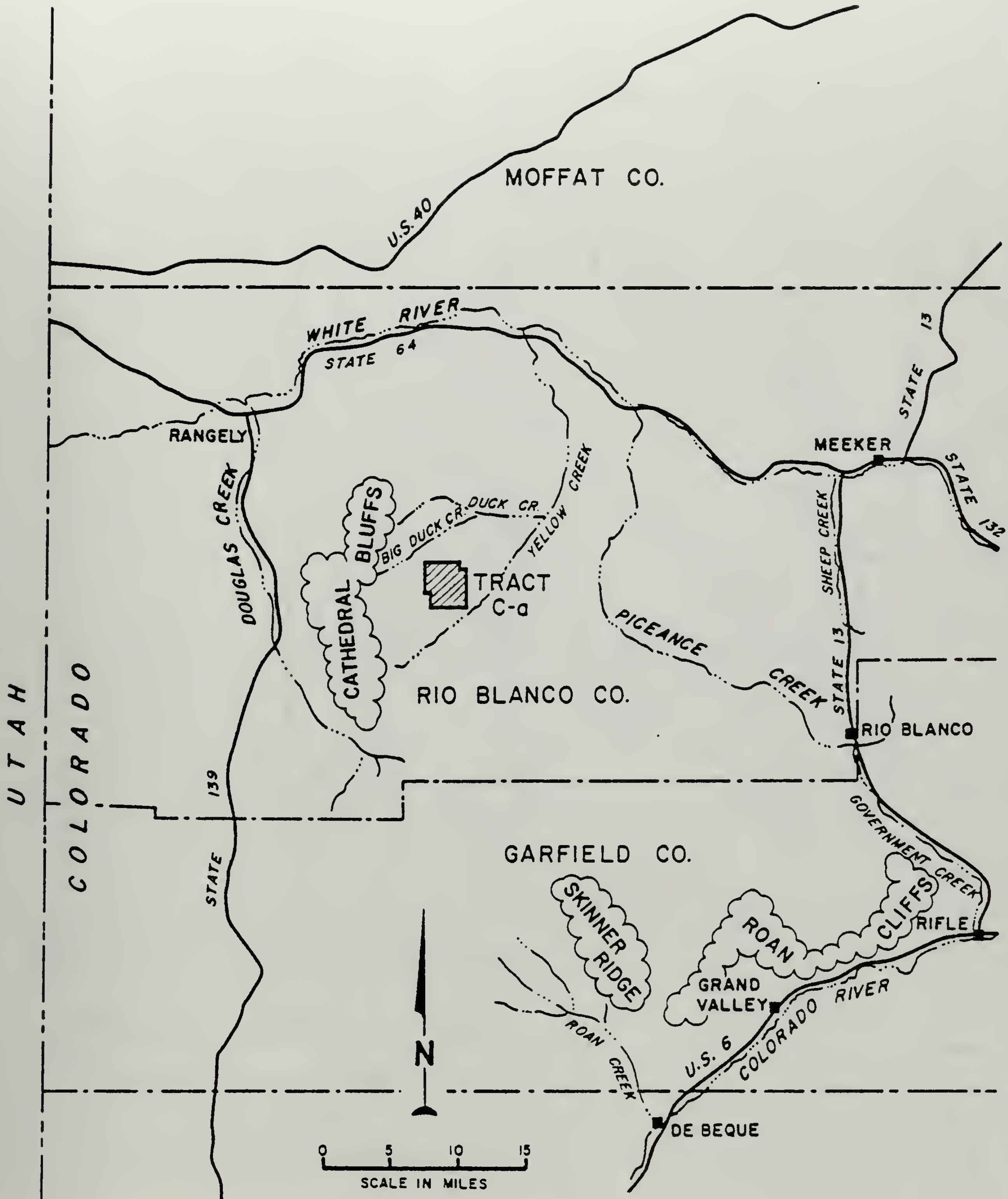
MOFFAT CO.
U.S. 40
WHITE RIVER
STATE 64
RANGELY
STATE 13
MEEKER
STATE 132
DOUGLAS CREEK
CATHEDRAL BLUFFS
BIG DUCK CR.
DUCK CR.
YELLOW CREEK
TRACT C-a
SHEEP CREEK
PICEANCE CREEK
STATE 13
RIO BLANCO
RIO BLANCO CO.
UTAH
COLORADO
STATE 139
GARFIELD CO.
GOVERNMENT CREEK
ROAN CLIFFS
RIFLE
SKINNER RIDGE
GRAND VALLEY
ROAN CREEK
U.S. 6
COLORADO RIVER
N
DE BEQUE
0 5 10 15
SCALE IN MILES

Figure 1

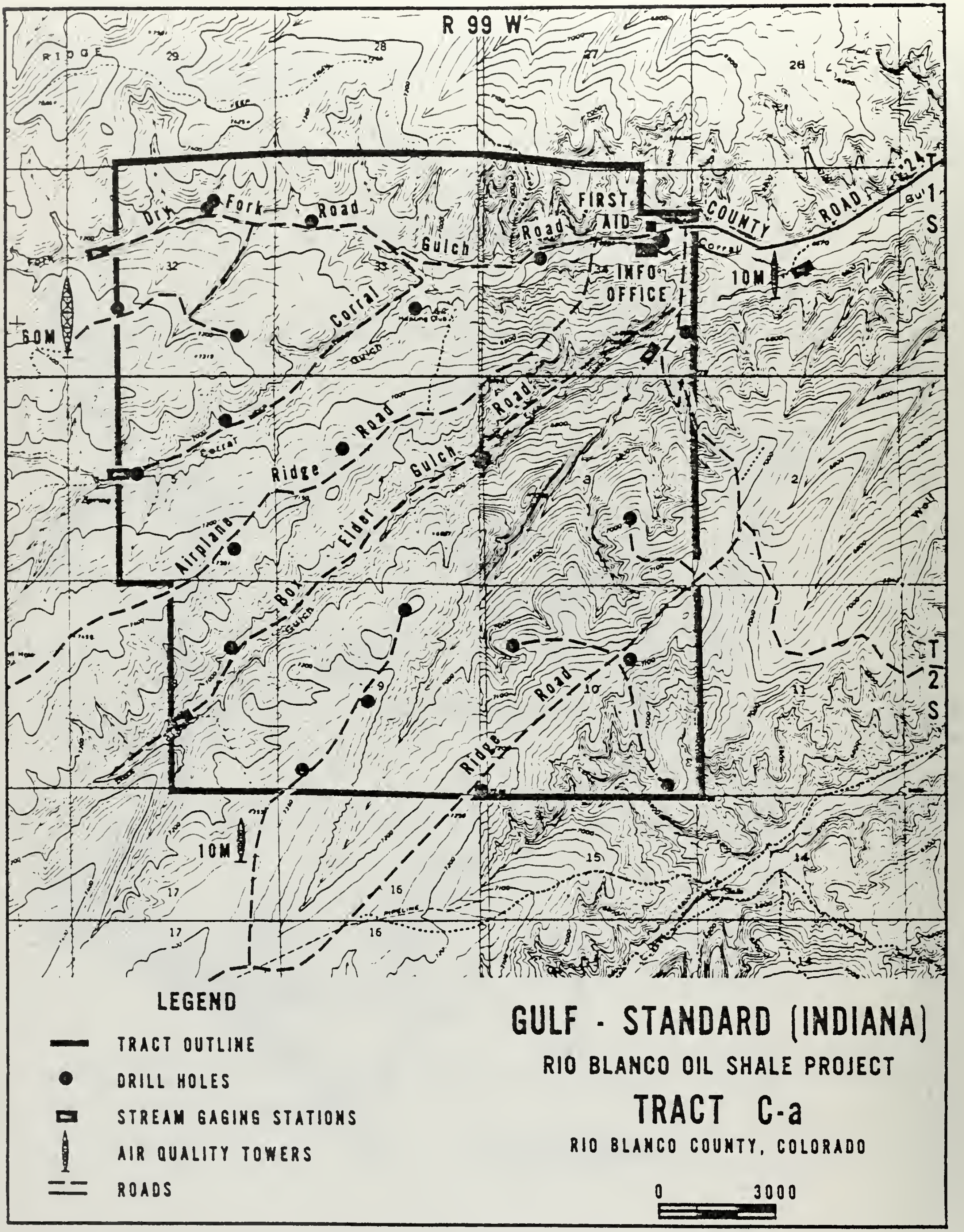
R 99 W
RIDGE
29
28
27
26
Dry Fork Road
FIRST AID
Road
Gulch
COUNTY ROAD
24
INFO OFFICE
Corral
10M
60M
32
33
34
Corral Gulch
Road
Ridge
Gulch
Airplane
Box Elder Gulch
Road
Ridge
1 S
2
T 2 S
8
9
10
11
15
14
17
16
10M
LEGEND
TRACT OUTLINE
DRILL HOLES
STREAM GAGING STATIONS
AIR QUALITY TOWERS
ROADS
GULF - STANDARD (INDIANA)
RIO BLANCO OIL SHALE PROJECT
TRACT C-a
RIO BLANCO COUNTY, COLORADO
0
3000

Figure 2

ABSTRACT

The Geotechnical Data Gathering Project initiated by RBOSP on Tract C-a in the spring and summer of 1974 provides data required for engineering studies as well as data necessary to establish baseline conditions. The data gathering consisted of specific tasks conducted under the geologic program and the hydrologic program. Previous RBOSP progress reports were organized to allow reporting of the ongoing activities of each task. Presently most of the major tasks under both the geologic and the hydrologic programs have been completed and consequently, the organization of the geotechnical data gathering portion of the Progress Reports has been restructured to include only those tasks in which activity was reported during the quarterly reporting period.

Activities conducted under the geologic program during the quarterly reporting period involved: completing revision of tract stratigraphic correlation network and zonal resource maps based on new assay data in three coreholes, G-S 2-3, 4-5, and 6; sample preparation of 1,116 feet of split core from corehole G-S7 by the USGS for quantitative trace element analyses; and completion of the 84 Mesa middle A-groove structure map.

Activities occurring under the hydrologic program were limited to the revised baseline monitoring program that has been approved by the AOSS. During the portion of the quarterly reporting period for which data has been processed, five stream gaging stations reported flows. Data from the three recording type rain gages for the quarterly reporting period are summarized below.

Recording Type Rain Gage Locations	Monthly Average (Inches)	Total (Inches) for Quarter
Stake Springs Draw near confluence with Corral Gulch	1.06	3.18
Yellow Creek near White River	.71	2.14
Cathedral Bluffs	1.62	4.87

The values on the table again demonstrate that the higher elevations in the Piceance Creek basin receive more precipitation than the lower elevations.

1.0 GEOTECHNICAL DATA GATHERING PROJECT

The geologic and hydrologic programs which make up the Geotechnical Data Gathering Project were initiated in the spring and summer of 1974. Both the geologic program and the hydrologic program are composites of a number of tasks as shown by the work breakdown structure, Figure 1.0-1. Nearly all of the tasks under both the programs have been completed prior to this reporting period. Therefore, the Geotechnical Data Gathering Project portion of this progress report has been structured to include a discussion on only the significant acitivities occurring during this quarterly reporting period.

Table 1.0-1 is an index in which significant activities related to the tasks and subtasks for each of the two programs are presented in previous progress report(s).

Activities occurring under the geologic program during the quarterly reporting period involved: (1) completing revision of the tract stratigraphic correlation network and zonal resource maps based on new assay data in three coreholes, G-S 2-3, 4-5, and 6; (2) sample preparation of 1116 feet of split core from corehole G-S 7 by the USGS for quantitative trace element analyses; and (3) completion of 84 Mesa middle A-groove structure map.

Activities conducted under the hydrologic program were limited to the revised baseline monitoring program that has been approved by the AOSS. The revised program consists of: collection and analyses of monthly samples from stream gaging stations; continuous monitoring of flow rate, sediment discharge, temperature, and specific conductance at the stream gaging stations; monthly monitoring and recording water levels in alluvial holes; collection of water samples during the months of November, February, April, May, June, July, August, and September from the alluvial monitoring holes; collection of water samples, semi-annually, from the deep aquifer monitor holes; and measuring water levels monthly from the deep aquifer monitor holes. The last semi-annual water sampling period for the deep aquifers was March, 1976. Analyses of samples taken during the last semi-annual sampling period which were not finished in time to include in RBOSP Progress Report 7 have been received and are included in this report.

Figure 1.0 - 1

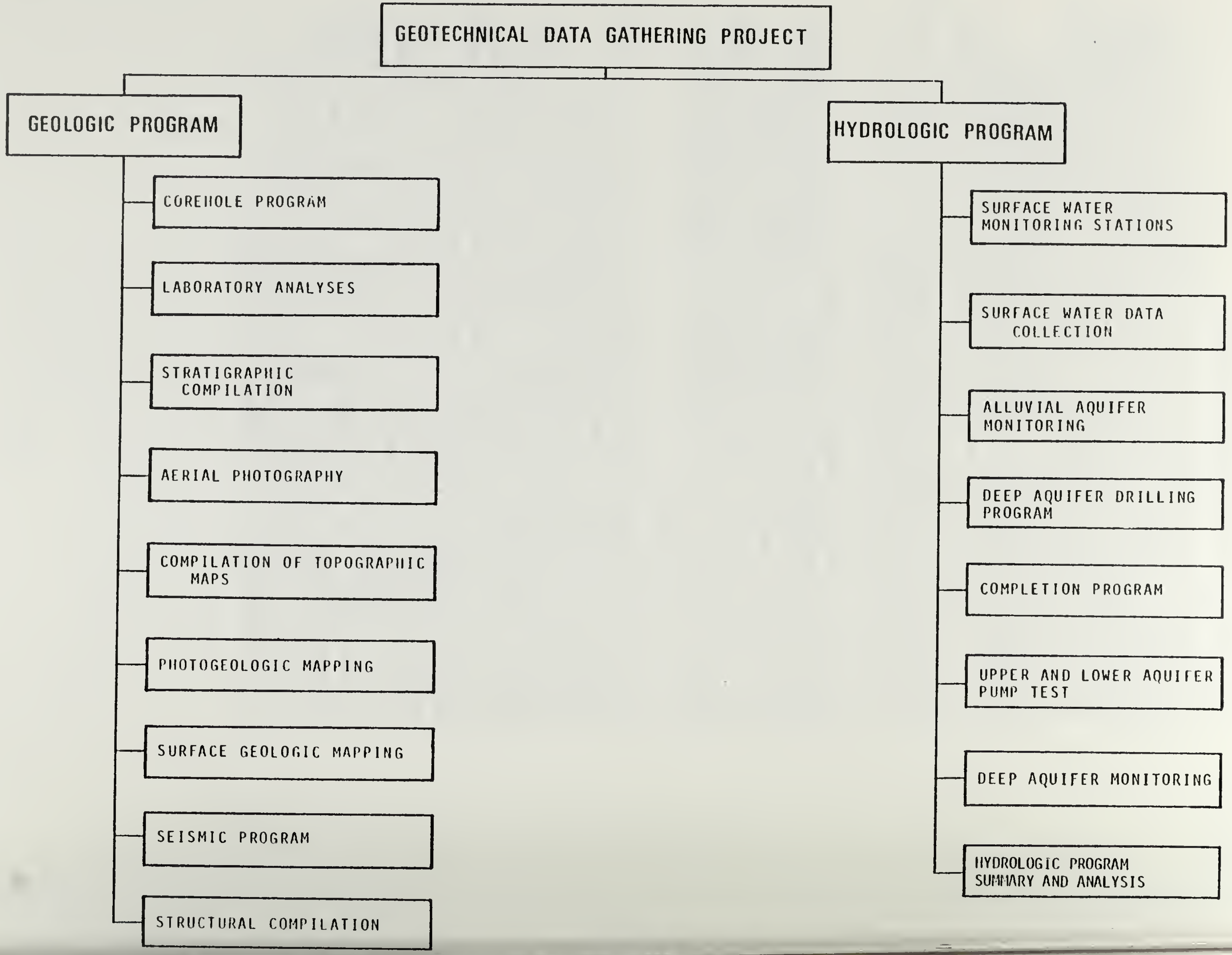
GEOTECHNICAL DATA GATHERING PROJECT
GEOLOGIC PROGRAM
HYDROLOGIC PROGRAM
COREHOLE PROGRAM
LABORATORY ANALYSES
STRATIGRAPHIC COMPILATION
AERIAL PHOTOGRAPHY
COMPILATION OF TOPOGRAPHIC MAPS
PHOTOGEOLOGIC MAPPING
SURFACE GEOLOGIC MAPPING
SEISMIC PROGRAM
STRUCTURAL COMPILATION
SURFACE WATER MONITORING STATIONS
SURFACE WATER DATA COLLECTION
ALLUVIAL AQUIFER MONITORING
DEEP AQUIFER DRILLING PROGRAM
COMPLETION PROGRAM
UPPER AND LOWER AQUIFER PUMP TEST
DEEP AQUIFER MONITORING
HYDROLOGIC PROGRAM SUMMARY AND ANALYSIS

Table 1.0-1

INDEX OF TASKS REPORTED IN PREVIOUS PROGRESS REPORTS

Task		Progress Reports(s)
1.1	Geologic Program	
1.1.1	Corehole Program.	2
1.1.2	Laboratory Analyses	2,3,4,5,6,7
1.1.2.1	Oil Shale Assays.	2,3,4,5,6
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1.1.8	Seismic Program	2
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1.2.1	Surface Water Monitoring Stations . .	2,3,4,5,6,7
1.2.2	Surface Water Data Collection	2,3,4,5,6,7
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1.2.6	Upper and Lower Aquifer Pumping Tests	3,4
1.2.7	Deep Aquifer Monitoring	2,3,4,5,6,7
1.2.8	Hydrologic Program Summary and Analysis.	4,5,6,7

1.1 Geologic Program

The activities occurring under the geologic program during the quarterly reporting period involved: (1) completing revision of tract stratigraphic correlations and zonal resource maps based on new assay data; (2) sample preparation of 1116 feet of core split from corehole G-S 7 by the USGS for quantitative analysis of nine trace elements, and (3) completion of the 84 Mesa middle A-groove structure map. Other tasks for the most part have been completed. Table 1.0-1, page 1.0-3, is an index showing in which previous progress reports results of these tasks have been presented.

Revision of tract stratigraphic correlations and zonal resource maps was required when new Fischer assay data were obtained of core samples from the Gulf-Standard (Indiana) corehole program. The new assay data is a result of earlier check-assaying of 45 samples from coreholes G-S 4-5 and G-S 6 which indicated that the entire stratigraphic interval from the R-2 zone through the R-5 zone required reassaying in each of the holes. In addition to these reassays, short core intervals from holes G-S 2-3, 4-5, and 6 which had been initially withheld from Fischer assay for rock mechanics testing were released for assay and assays completed. This combination of new assay data constituted the basis for the geologic revisions.

The new assay data resulted in slight revision of zonal boundaries in the northeast part of Tract C-a. It also caused zonal resource map changes in the same general area. Although some zonal oil shale grades changed significantly, the overall resources of the tract were only slightly affected because some zonal grades increased while others decreased, thereby compensating for one another.

Appropriate revisions were made to the tract correlation network which consists of sets of density log cross sections and oil shale grade histogram log cross sections. Revised cross sections have been submitted to the AOSS. The revision of zonal resource maps was completed and also submitted to the AOSS.

A 1,116 foot core split from corehole G-S 7 was submitted to the USGS for quantitative analysis of nine specific trace elements. The nine trace elements are vanadium and molybdenum together with the following seven trace elements which were included in the original Rio Blanco analyses program: antimony, arsenic, boron, cadmium, fluoride, mercury and selenium. For the purpose of direct comparison between the results, the USGS analyses will be conducted on composite core intervals identical to those Rio Blanco had analyzed. The USGS will furnish representative and sufficient sized splits of the composite samples to Rio Blanco in the event that Rio Blanco should decide to run additional check-analyses on the composite splits. Additional checking, if done, may resolve variations in analysis results due to sample preparation, sample contamination, difference in lab procedures, etc. At the end of this quarterly reporting period (August, 1976) analyses of trace elements by the USGS have not yet been completed, however, sample preparation has been completed and analysis should begin soon. Results will be reported in future progress reports as they are obtained.

The 84 Mesa middle A-groove structure map was completed during the quarterly reporting period and transmitted to the Area Oil Shale Supervisor. The map is a compilation of all subsurface, photogeologic, and surface geologic mapping control gathered to date by RBOSP in the area of the proposed 84 Mesa off-tract disposal site.

1.2 Hydrologic Program

Rio Blanco Oil Shale Project initiated surface water data collection and monitoring in March of 1974. Deep and alluvial aquifer data collection and monitoring was initiated in December 1974. These two main categories of tasks make up the Hydrologic Program that was implemented to establish baseline hydrologic conditions and to acquire data required for the design and planning of mine dewatering. Activity occurring during the quarterly reporting period under the hydrologic program are covered in RBOSP Progress Report 8, submitted in two parts: (1) Interpretative Text, and (2) Raw Data. Only those tasks for which activity occurred during the quarter are reported in this progress report summary. Table 1.0-1, page 1.0-3, shows in which progress report significant activity for any specific task was reported.

1.2.1 Surface Water Monitoring Stations

RBOSP has contracted with the Colorado River Water Conservation District to have the Water Resources Division (WRD) of the United States Geological Survey (USGS) construct and operate surface water monitoring stations. Table 1.2-1 lists each of the eleven stream gaging stations and the six rain gaging stations, the USGS identification number, and a description of the location of each station. Figure 1.2-1 shows the location of the stream gaging stations and the rain gaging stations in addition to alluvial aquifer monitor holes.

1.2.2 Surface Water Data Collection

Due to the length of time required for processing and reporting data from the stream gaging stations, the progress reports generally include data from the latter part of the preceding quarterly reporting periods and omit data from the latter part of the quarterly currently being reported.

1.2.2.1 Streamflow

Stream gaging stations located along perennial reaches of streams which recorded flow during the quarterly reporting period included: Corral Gulch near west line Tract C-a; Box Elder Gulch near west line Tract C-a, Corral Gulch east of Tract C-a; Corral Gulch south of 84 Mesa; and Yellow Creek near White River. Table 1.2-2 shows the maximum and minimum discharges for the stations reporting flow.

Flow in Corral Gulch near west line Tract C-a remained relatively stable during this recording period, and averaged about

TABLE 1.2-1

LOCATION AND USGS IDENTIFICATION NUMBERS FOR SURFACE AND RAIN GAGING STATIONS

USGS Identification Number	LOCATION
09306230	Stake Springs Draw near confluence with Corral Gulch
09306235	Corral Gulch near west line Tract C-a
09306237	Dry Fork near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
09306241	"Rinky Dink" Gulch near east line Tract C-a
09306242	Corral Gulch east of Tract C-a
09306244	Corral Gulch near 84 Ranch
09306246	Tributary to Yellow Creek east of 84 Mesa
09306248	Upper Big Duck Creek north of 84 Mesa
09306250	Lower Big Duck Creek north of 84 Mesa
09306255	Stake Springs Draw near confluence with Corral Gulch
	STORAGE-TYPE RAIN GAGES
09306235	Corral Gulch near west line Tract C-a
09306237	Dry Fork near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
	RAINFALL INTENSITY AND RECORDING RAIN GAGES
09306230	Stake Springs Draw near confluence with Corral Gulch
09306255	Yellow Creek Near White River, Colorado
No Number	Crathedral Bluffs located in NW¼, NW¼, Sec. 14, T2S, R100W

Figure 1.2-1
STREAM GAGING STATIONS,
RAIN GAGING STATIONS
AND
ALLUVIAL AQUIFER MONITORING HOLES

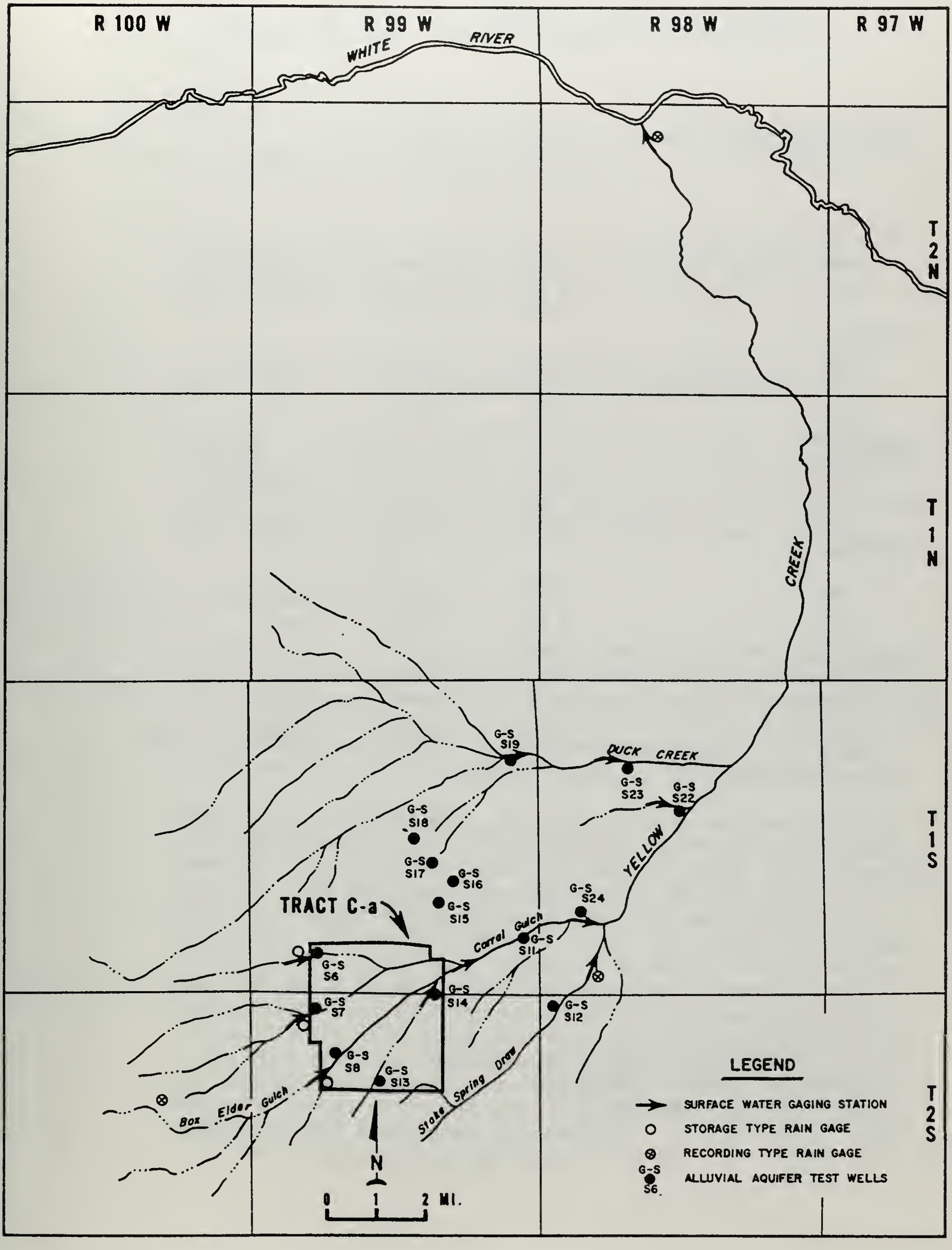

TABLE 1.2-2

MAXIMUM AND MINIMUM DISCHARGE (CFS) FOR GAGING STATIONS REPORTING FLOW DURING MAY, JUNE, JULY, AND AUGUST

USGS IDENTIFICATION NUMBER (1)	MAY	JUNE	JULY	AUGUST
09306235				
Max	0.15	0.15	0.12	---
Min	0.02	0.08	0.08	---
09306240				
Max	0.08	0.65	NF	---
Min	NF	0.02	NF	---
09306242				
Max	1.0	0.72	0.92(3)	---
Min	0.42	0.35	0.70	---
09306244				
Max	0.22	0.20(2)	0.10	---
Min	0.15	0.10	NF	---
09306255				
Max	1.80	1.40	0.60	3.8(3)
Min	1.20	0.70	0.25	0.7

(1) See Table 1.2-1
(2) Equipment malfunction data prorated
(3) Data not complete for month
--- Data not yet received
NF No Flow

0.15 cfs (cubic feet per second). This average flow rate is less than the average flow rates for the previous two water years.

Flow in Box Elder Gulch near west line Tract C-a was intermittent. A continuous flow from May 15 to May 24 that peaked at 0.8 cfs, was the longest duration of flow recorded for this station during the 1976 water year.

Corral Gulch east of Tract C-a had flow values comparable to those of previous years of record. Average flow for this reporting period was about 0.6 cfs, with a peak of 1.0 cfs in May and a low of 0.35 cfs in June.

Corral Gulch south of 84 Mesa experienced decreasing flow rates from 0.2 cfs to no flow during this recording period.

The flow in Yellow Creek near White River showed a general downward trend during this recording period. The average was about 1.5 cfs with a high of 3.8 cfs and a low of 0.25 cfs. These flows correspond to those recorded during the 1975 water year except that the minimum flow for water year 1976 was lower than for 1975.

1.2.2.2 Surface-Water Quality

Table 1.2-3 is a data collection schedule for the stream gaging station. Summaries of the water quality analyses of water samples collected at the stream gaging stations reporting flow during the quarter are presented in Tables 1.2-4 to 1.2-8. Detailed water quality data are presented in the Interpretative Text and Raw Data portions of this progress report.

Continuous recording mean conductivity and mean temperature instruments are located at all surface water gaging stations. However, there are only four stations for which "continuous" recordings of data were reported during the 1976 water year, and all of these had periods when no data were obtained. These are: Corral Gulch east of Tract C-a, Corral Gulch west of Tract C-a, Corral Gulch north of 84 Mesa, and Yellow Creek near the White River. The only continuous records of mean conductivity available for Corral Gulch near west line Tract C-a during the 1976 water year are for the first three weeks of October 1975 and from the end of April to July 20, 1976. The average conductivity for the October 1975 data was 800 umhos/cm (michcromhos per centimeter) whereas for the period April-July the average was 400 umhos/cm. A peak of 850 umhos/cm occurred between June 20 and July 1, 1976.

TABLE 1.2-3

DATA COLLECTION SCHEDULE FOR STREAM GAGING STATIONS

Continuously or Automatically

- Flow Rate
- Sediment Discharge
- Temperature
- Specific Conductance

Periodically

- Storage Rain Gages
- Recording Rain Gages
- Rainfall Intensity Gages

Monthly

Water Samples Analyzed For:

- Alkalinity
- Biological Oxygen Demand
- Dissolved Organic Carbon
- Boron
- Calcium
- Conductance
- Fluoride
- Magnesium
- Potassium
- Silica
- Sodium
- Sulfate
- Ammonia
- Bicarbonate
- Carbonate
- Chloride
- Color
- Dissolved Solids
- Kjeldahl Nitrogen
- Nitrate plus Nitrite
- Odor
- Dissolved Phosphate
- Turbidity
- Dissolved Oxygen
- pH
- Temperature
- Total Phosphate
- Ortho Phosphate
- Suspended Organ Carbon

Quarterly

Sample and Analyze:

- COD
- Fecal Coliform
- Pesticides
- Polycyclic Aromatics
- Total Coliform
- Bromide
- Cyanide
- MBAS
- Oil & Grease
- Phenols
- Sulfide
- Radioactivity
  - Gross Alpha
    - 4 pci/l
    - ^{226}Ra
  - Gross Beta
    - 100 pci/l
    - ^{90}Sr
    - ^{137}Ce
- Ba
- Be
- Ge
- Ga
- Ni
- Ti
- V
- Zr
- Al
- As
- Cd
- Cr
- Cu
- Fe
- Pb
- Li
- Mn
- Mo
- Hg
- Se
- Sr
- Zn

Table 1.2-4
SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306235
CORRAL GULCH NEAR WEST LINE TRACT C-a
YEAR 1976

	Jan. 02	May 25	June 24	July 21							
1. Alkalinity (mg/l)	343	278	267	294							
2. Aluminum (ug/l)	30	--	50	--							
3. Ammonia (mg/l)	.12	.03	.03	.06							
4. Aromatics, Polycyclic											
5. Arsenic (ug/l)	4	--	7	--							
6. Barium (ug/l)	60	--	70	--							
7. Beryllium (ug/l)	<3	--	<6	--							
8. Bicarbonate (mg/l)	418	339	325	358							
9. Bismuth (ug/l)	<15	--	<20	--							
10. Boron (ug/l)	80	90	110	120							
11. Cadmium (ug/l)	7	--	1	--							
12. Carbonate (mg/l)	0	0	0	0							
13. Carbon Dioxide (mg/l)											
14. Chloride (mg/l)	11	12	8.0	8.8							
15. Chromium (ug/l)	<15	--	10	--							
16. Cobalt (ug/l)	<15	--	<15	--							
17. COD	12	--	5	--							
18. Coliform, Total & Fecal											
19. Color (PCU)	5	8	4	25							
20. Conductivity, Specific	1100	1050	1050	1000							
21. Copper (ug/l)	5	--	5	--							
22. Cyanide (mg/l)	.00	--	.0	--							
23. Discharge (CFS)											
24. Discharge, Instantaneous	.50	.10	.09	.10							
25. Dissolved Oxygen (mg/l)		7.5	--	6.8							
26. Fluoride (mg/l)	.3	.3	.3	.3							
27. Gallium (ug/l)	<7	--	<6	--							
28. Germanium (ug/l)	<40	--	<20	--							
29. Hardness (Ca, Mg) (mg/l)	490	400	390	410							
30. Hardness, Non-Carbonate (mg/l)	140	120	120	120							
31. Iron (ug/l)	30	--	30	--							
32. Kjeldahl Nitrogen (mg/l)	.69	.37	.42	.84							
33. Lead (ug/l)	<15	--	3	--							
34. Lithium (ug/l)	20	--	20	--							
35. Magnesium (mg/l)	60	58	58	58							
36. Manganese (ug/l)	20	--	<10	--							
37. Mercury (ug/l)	.0	--	.0	--							
38. Molybdenum (ug/l)	40	--	50	--							
39. Nickel (ug/l)	<15	--	<15	--							
40. Nitrate (mg/l)											
41. Nitrite (mg/l)											
42. Nitrite Plus Nitrate (mg/l)	1.1	.52	.28	.53							
43. Nitrogen, Ammonia	.09	.02	.02	.05							
44. Odor (Severity)											
45. Oil & Grease (mg/l)	0	--	8	--							
46. Ortho-Phosphate (mg/l)											
47. Ortho-Phosphorus (mg/l)	.00	.0	.02	.0							
48. Pesticides	0										
49. pH	--	7.9	8.1	8.3							
50. Phosphorus, Total (mg/l)	.02	.01	.01	.09							
51. Potassium (mg/l)	1.5	1.4	1.5	2.8							
52. Selenium (ug/l)	2	--	4	--							
53. Silica (mg/l)	19	20	18	22							
54. Silver (ug/l)	<2	--	<2	--							
55. Sodium (mg/l)	84	85	94	93							
56. Sodium Adsorption Ratio	1.7	1.8	2.1	2.0							
57. Sodium ( )	27	31	35	33							
58. Solids, Dissolved (mg/l)	793	681	701	723							
59. Solids, Dissolved T/D	.11	.18	.17	.20							
60. Solids, Dissolved T/Ac-Ft	1.08	.93	.95	.98							
61. Solids, Suspended											
62. Strontium (ug/l)	1300	--	1700	--							
63. Sulfate (mg/l)	310	270	300	290							
64. Sulfide (mg/l)	.0	--	.5	--							
65. Temperature (°C)	.5	23.0	24.5	30.0							
66. Tin (ug/l)	<15	--	<15	--							
67. Titanium (ug/l)	<10	--	<10	--							
68. Turbidity (JTU)											
69. Vanadium (ug/l)	<15	--	<15	--							
70. Zinc (ug/l)	10	--	0	--							
71. Zirconium (ug/l)	<40	--	<30	--							
72. Calcium (mg/l)	95	65	58	69							
73. Complete Element Span											
74. Radioactivity											
Gross Alpha (pci)	<9.8	--	<10.3	--							
Radium 226*	0.8	--	--	--							
Gross Beta	5.2	--	2.8	--							
Thorium 230**											
Uranium**											
75. Total Organic Carbon (mg/l)	16.5										
If TOC 10 mg/liter, then											
Nitrogen (Base Extraction)											
Organic Carbon, Dissolved	14	4.6	7.4	16							
Organic Carbon, Suspended	2.5	--	.3	.0							
Phenols											
Sulfur (Acid Extraction)											
76. Total Ortho-Phosphorous (mg/l)	.00										
77. Phosphate	.06	.03	.03	.28							
78. Phosphorus, Dissolved											

Table 1.2-5
SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306240
BOX ELDER GULCH NEAR WEST LINE TRACT C-a
YEAR 1976

	Mar. 18	May 25	June 24							
1. Alkalinity (mg/l)	74	254								
2. Aluminum (ug/l)	40	--	130							
3. Ammonia (mg/l)	.32	.01								
4. Aromatics, Polycyclic										
5. Arsenic (ug/l)										
6. Barium (ug/l)	50	--	70							
7. Beryllium (ug/l)	<1	--	<5							
8. Bicarbonate (mg/l)	90	310								
9. Bismuth (ug/l)	<4	--	<15							
10. Boron (ug/l)	110	60								
11. Cadmium (ug/l)	1									
12. Carbonate (mg/l)	0	0								
13. Carbon Dioxide (mg/l)										
14. Chloride (mg/l)	3.0	5.5								
15. Chromium (ug/l)	<3	--	<10							
16. Cobalt (ug/l)	<3	--	<10							
17. COD	100									
18. Coliform, Total & Fecal										
19. Color (PCU)	100	12								
20. Conductivity, Specific	163	750								
21. Copper (ug/l)	13									
22. Cyanide (mg/l)	.00									
23. Discharge (CFS)										
24. Discharge, Instantaneous	.01	.57								
25. Dissolved Oxygen (mg/l)		6.7								
26. Fluoride (mg/l)	.1	.3								
27. Gallium (ug/l)	<1	--	<5							
28. Germanium (ug/l)	<3	--	<20							
29. Hardness (Ca, Mg) (mg/l)	65	310								
30. Hardness, Non-Carbonate (mg/l)	0	53								
31. Iron (ug/l)	280	--	30							
32. Kjeldahl Nitrogen (mg/l)	30	.42								
33. Lead (ug/l)	13		<10							
34. Lithium (ug/l)	10		20							
35. Magnesium (mg/l)	5.4	42								
36. Manganese (ug/l)	30	--	<7							
37. Mercury (ug/l)	.0									
38. Molybdenum (ug/l)	3	--	40							
39. Nickel (ug/l)	<3	--	<10							
40. Nitrate (mg/l)										
41. Nitrite (mg/l)										
42. Nitrite Plus Nitrate (mg/l)	.23	.72								
43. Nitrogen, Ammonia	.25	.01								
44. Odor (Severity)										
45. Oil & Grease (mg/l)	2									
46. Ortho-Phosphate (mg/l)										
47. Ortho-Phosphorus (mg/l)	.35	.0								
48. Pesticides	0									
49. pH	8.1	8.1								
50. Phosphorus, Total (mg/l)	.83	.56								
51. Potassium (mg/l)	11	1.0								
52. Selenium (ug/l)	0									
53. Silica (mg/l)	3.2	24								
54. Silver (ug/l)	0	--	<2							
55. Sodium (mg/l)	2.7	51								
56. Sodium Adsorption Ratio	.1	1.3								
57. Sodium ( )	7	26								
58. Solids, Dissolved (mg/l)	95	474								
59. Solids, Dissolved T/D	.00	.73								
60. Solids, Dissolved T/Ac-Ft	.13	.64								
61. Solids, Suspended										
62. Strontium (ug/l)	190	--	920							
63. Sulfate (mg/l)	5.5	140								
64. Sulfide (mg/l)	.2	--								
65. Temperature (°C)	3.0	24								
66. Tin (ug/l)	<5	--	<10							
67. Titanium (ug/l)	<1	--	< 7							
68. Turbidity (JTU)										
69. Vanadium (ug/l)	<3.0	--	<10							
70. Zinc (ug/l)	30	--	0							
71. Zirconium (ug/l)	<5	--	< 20							
72. Calcium (mg/l)	17	54								
73. Complete Element Scan										
74. Radioactivity										
Gross Alpha (pci)	4.7	--	11							
Radium 226*										
Gross Beta	16.4	--	4.8							
Thorium 230**										
Uranium**										
75. Total Organic Carbon (mg/l)	36.4									
If TOC 10 mg/liter, then										
Nitrogen (Base Extraction)	30	.41								
Organic Carbon, Dissolved	34	4.2								
Organic Carbon, Suspended	2.4	--								
Phenols										
Sulfur (Acid Extraction)										
76. Total Ortho-Phosphorous (mg/l)	.35									
77. Phosphate	2.5	1.7								
78. Phosphorus, Dissolved										

Table 1.2-6
SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306242
CORRAL GULCH EAST OF TRACT C-a
YEAR 1976

	Jan. 29	Feb. 18	Mar. 11	Apr. 15	May 13	June 25	July 21				
1. Alkalinity (mg/l)	362	414	419	367	395		363				
2. Aluminum (ug/l)	10	10	20	--	--	100	--				
3. Ammonia (mg/l)	.05	--	.05	.12	.13		.04				
4. Aromatics, Polycyclic											
5. Arsenic (ug/l)	4	4	6	--	--		--				
6. Barium (ug/l)			60			60					
7. Beryllium (ug/l)			<4			<7					
8. Bicarbonate (mg/l)	441	505	511	488	481		442				
9. Bismuth (ug/l)			<25			20					
10. Boron (ug/l)	140	120	100	150	180	90	120				
11. Cadmium (ug/l)			1								
12. Carbonate (mg/l)	0	0	0	0	0		0				
13. Carbon Dioxide (mg/l)											
14. Chloride (mg/l)	10	9.4	12	11	12		11				
15. Chromium (ug/l)			<20			<15					
16. Cobalt (ug/l)			<20			<15					
17. COD			12								
18. Coliform, Total & Fecal			2								
19. Color (PCU)	3	4	4	0	0		12				
20. Conductivity, Specific	1200	1300	1250	1300	1200		1320				
21. Copper (ug/l)			3								
22. Cyanide (mg/l)			.00								
23. Discharge (CFS)											
24. Discharge, Instantaneous	.42	.55	.35	.53	--		.75				
25. Dissolved Oxygen (mg/l)	7.7	10.9	10.0	7.0	10.1		6.9				
26. Fluoride (mg/l)	.4	.4	.4	.4	.4		.4				
27. Gallium (ug/l)			<7			<7					
28. Germanium (ug/l)			<20			<20					
29. Hardness (Ca, Mg) (mg/l)	470	460	520	510	480		430				
30. Hardness, Non-Carbonate (mg/l)	110	42	98	140	90		69				
31. Iron (ug/l)	10	10	<20	--	--	60	--				
32. Kjeldahl Nitrogen (mg/l)	.40	.22	.11	--	.35		.92				
33. Lead (ug/l)			<20			<15					
34. Lithium (ug/l)			20			20					
35. Magnesium (mg/l)	63	60	70	69	65		55				
36. Manganese (ug/l)			40			<20					
37. Mercury (ug/l)			.0								
38. Molybdenum (ug/l)			50			50					
39. Nickel (ug/l)			<20			<15					
40. Nitrate (mg/l)											
41. Nitrite (mg/l)											
42. Nitrite Plus Nitrate (mg/l)	34	.37	.33	.32	<.32		.18				
43. Nitrogen, Ammonia	.04	--	.04	.09	.10		.03				
44. Odor (Severity)											
45. Oil & Grease (mg/l)			0								
46. Ortho-Phosphate (mg/l)											
47. Ortho-Phosphorus (mg/l)	.01	.05	.01	.01	.01		.00				
48. Pesticides											
49. pH	7.8	8.2	7.7	7.5	8.2		7.8				
50. Phosphorus, Total (mg/l)	.00	.03	.04	--	.16		.04				
51. Potassium (mg/l)	1.5	1.4	1.7	2.4	1.5		1.7				
52. Selenium (ug/l)			<2								
53. Silica (mg/l)	20	20	21	22	21		21				
54. Silver (ug/l)			<2			<2					
55. Sodium (mg/l)	110	100	120	120	110		98				
56. Sodium Adsorption Ratio	2.2	2.0	2.3	2.3	2.2		2.1				
57. Sodium (%)	34	32	34	34	33		33				
58. Solids, Dissolved (mg/l)	821	787	872	837	816		748				
59. Solids, Dissolved T/D	.93	1.17	.82	1.20	--		1.51				
60. Solids, Dissolved T/Ac-Ft	1.12	1.07	1.19	1.14	1.11		1.02				
61. Solids, Suspended											
62. Strontium (ug/l)	2000	1800	1700	--	--	1600	--				
63. Sulfate (mg/l)	310	260	300	300	280		260				
64. Sulfide (mg/l)			.0								
65. Temperature (°C)	3.5	.0	9.0	12	13		22				
66. Tin (ug/l)			<20			< 15					
67. Titanium (ug/l)			<10			< 10					
68. Turbidity (JTU)											
69. Vanadium (ug/l)			<10			< 15					
70. Zinc (ug/l)			10			20					
71. Zirconium (ug/l)			<30			< 30					
72. Calcium (mg/l)	85	83	91	90	87		82				
73. Streptococci	--	--	2	--	--		--				
74. Radioactivity											
Gross Alpha (pci)			<9.1			<12.4					
Radium 226*											
Gross Beta			3.7			2.5					
Thorium 230**											
Uranium**											
75. Total Organic Carbon (mg/l)	14.3	7.0	4.5								
If TOC >10 mg/liter, then											
Nitrogen (Base Extraction)	.36	--	.07	--	.25		.89				
Organic Carbon, Dissolved	14	6.7	4.2	--	--		12				
Organic Carbon, Suspended	.3	.3	.3	--	--		11				
Phenols											
Sulfur (Acid Extraction)											
76. Total Ortho-Phosphorous (mg/l)	.01	.05	.01								
77. Phosphate	.00	.39	.12	--	.49		.12				
78. Phosphorus, Dissolved											

Table 1.2-7
SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306244
CORRAL GULCH SOUTH OF 84 MESA
YEAR 1976

	Jan. 29	Feb. 18	Mar. 11	May 13	June 26
1. Alkalinity (mg/l)	523	505	489	469	
2. Aluminum (ug/l)	10	10	<20	--	40
3. Ammonia (mg/l)	.06	.19	.10	.05	
4. Aromatics, Polycyclic					
5. Arsenic (ug/l)	2	2	4	--	
6. Barium (ug/l)			200		100
7. Beryllium (ug/l)			<5		<10
8. Bicarbonate (mg/l)	638	616	596	572	
9. Bismuth (ug/l)			<35		<40
10. Boron (ug/l)	180	160	150	40	140
11. Cadmium (ug/l)			1		
12. Carbonate (mg/l)	0	0	0	0	
13. Carbon Dioxide (mg/l)					
14. Chloride (mg/l)	18	19	16	17	
15. Chromium (ug/l)			<25		<30
16. Cobalt (ug/l)			<25		<30
17. COD			26		
18. Coliform, Total & Fecal			94		
19. Color (PCU)	4	15	15	5	
20. Conductivity, Specific	1750	1900	1700	1820	
21. Copper (ug/l)			2		
22. Cyanide (mg/l)			.00		
23. Discharge (CFS)					
24. Discharge, Instantaneous	.01	.10	.07	--	
25. Dissolved Oxygen (mg/l)	5.1	11.7	13.4	9.2	
26. Fluoride (mg/l)	.3	.4	.3	.3	
27. Gallium (ug/l)			<10	[illegible]	<10
28. Germanium (ug/l)			<30		<40
29. Hardness (Ca, Mg) (mg/l)	730	690	680	660	
30. Hardness, Non-Carbonate (mg/l)	210	180	190	190	
31. Iron (ug/l)	20	30	<30	--	<30
32. Kjeldahl Nitrogen (mg/l)	.76	1.0	.96	.46	
33. Lead (ug/l)			<25		
34. Lithium (ug/l)			10		20
35. Magnesium (mg/l)	110	100	97	100	
36. Manganese (ug/l)			60		220
37. Mercury (ug/l)			.0		
38. Molybdenum (ug/l)			60		60
39. Nickel (ug/l)			<25		<30
40. Nitrate (mg/l)					
41. Nitrite (mg/l)					
42. Nitrite Plus Nitrate (mg/l)	.71	.35	.68	<.04	
43. Nitrogen, Ammonia	.05	.15	.08	.04	
44. Odor (Severity)					
45. Oil & Grease (mg/l)			0		
46. Ortho-Phosphate (mg/l)					
47. Ortho-Phosphorus (mg/l)	.02	.01	.03	.00	
48. Pesticides			0		
49. pH	7.8	8.2	8.3	8.2	
50. Phosphorus, Total (mg/l)	.00	.05	.06	.85	
51. Potassium (mg/l)	2.6	2.7	3.0	2.6	
52. Selenium (ug/l)			2		
53. Silica (mg/l)	17	18	20	17	
54. Silver (ug/l)			<3		<4
55. Sodium (mg/l)	190	170	170	190	
56. Sodium Adsorption Ratio	3.1	2.8	2.9	3.2	
57. Sodium (%)	36	35	35	38	
58. Solids, Dissolved (mg/l)	1380	1240	1210	1230	
59. Solids, Dissolved T/D	.04	.33	.23	--	
60. Solids, Dissolved T/Ac-Ft	1.88	1.69	1.65	1.67	
61. Solids, Suspended					
62. Strontium (ug/l)	2800	2700	2300	--	2500
63. Sulfate (mg/l)	610	510	490	520	
64. Sulfide (mg/l)			.2		
65. Temperature (°C)	6.0	8.0	9.0	21.0	
66. Tin (ug/l)			<20		<30
67. Titanium (ug/l)			<20		<20
68. Turbidity (JTU)					
69. Vanadium (ug/l)			<15		<30
70. Zinc (ug/l)			10		20
71. Zirconium (ug/l)			10		<50
72. Calcium (mg/l)	110	110	110	100	
73. Complete Element Span					
74. Radioactivity					
Gross Alpha (pci)	<7.8		<12.4		10.6
Radium 226*			.02		--
Gross Beta	4.5		22.6		15.2
Thorium 230**					
Uranium**					
75. Total Organic Carbon (mg/l)	11.4	13.7	13.3		
If TOC >10 mg/liter, then					
Nitrogen (Base Extraction)					
Organic Carbon, Dissolved	11	13	13	7.4	
Organic Carbon, Suspended	.4	.7	.3	--	
Phenols					
Sulfur (Acid Extraction)					
76. Total Ortho-Phosphorous (mg/l)					
77. Phosphate	.00	.15	.18	2.6	
78. Phosphorus, Dissolved					

Table 1.2-8
SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306255
YELLOW CREEK NEAR WHITE RIVER
YEAR 1976

	Jan. 28	Feb. 26	March 30	Apr. 9	May 25	June 23					
1. Alkalinity (mg/l)	1670	1280	1530	1520	1870						
2. Aluminum (ug/l)	20	50	110	--	--	100					
3. Ammonia (mg/l)	.35	.30	0.18	0	.04						
4. Aromatics, Polycyclic											
5. Arsenic (ug/l)	4	6	--	--	--						
6. Barium (ug/l)			20			100					
7. Beryllium (ug/l)			<10			< 20					
8. Bicarbonate (mg/l)	1460	596	1390	1580	1860						
9. Bismuth (ug/l)			< 70			< 70					
10. Boron (ug/l)	690	580	720	680	750	820					
11. Cadmium (ug/l)			1								
12. Carbonate (mg/l)	283	478	240	136	207						
13. Carbon Dioxide (mg/l)											
14. Chloride (mg/l)	150	130	140	140	140						
15. Chromium (ug/l)			0			<50					
16. Cobalt (ug/l)			<50			< 50					
17. COD			15								
18. Coliform, Total & Fecal											
19. Color (PCU)	5	20	10	20	22						
20. Conductivity, Specific	3880	2300	3700	4000	3500						
21. Copper (ug/l)			4								
22. Cyanide (mg/l)			0.00								
23. Discharge (CFS)											
24. Discharge, Instantaneous	2.0	3.5									
25. Dissolved Oxygen (mg/l)	12.2	10.9	11.1	8.5	--						
26. Fluoride (mg/l)	2.5	2.0	2.4	2.6	2.6						
27. Gallium (ug/l)			< 20	.		<20					
28. Germanium (ug/l)			<70			< 70					
29. Hardness (Ca, Mg) (mg/l)	590	550	500	530	510						
30. Hardness, Non-Carbonate (mg/l)	0	0	0	0	0						
31. Iron (ug/l) .	20	20	70	--	--	80					
32. Kjeldahl Nitrogen (mg/l)	1.0	.90	--	.47	.40						
33. Lead (ug/l)			<50			<50					
34. Lithium (ug/l)			150			200					
35. Magnesium (mg/l)	120	110	100	110	120						
36. Manganese (ug/l)			<30			<30					
37. Mercury (ug/l)			0								
38. Molybdenum (ug/l)			80			40					
39. Nickel (ug/l)			<50			<50					
40. Nitrate (mg/l)											
41. Nitrite (mg/l)											
42. Nitrite Plus Nitrate (mg/l)	1.6	1.2	1.0	.51	.01						
43. Nitrogen, Ammonia	.27	.23	.14	.00	.03						
44. Odor (Severity)											
45. Oil & Grease (mg/l)			0								
46. Ortho-Phosphate (mg/l)											
47. Ortho-Phosphorus (mg/l)											
48. Pesticides											
49. pH	8.7	8.7	8.7	8.6	8.8						
50. Phosphorus, Total (mg/l)	.16	.46	.12	.24	.07						
51. Potassium (mg/l)	4.2	4.1	7.0	5.0	4.4						
52. Selenium (ug/l)			1								
53. Silica (mg/l)	13	14	12	11	9.6						
54. Silver (ug/l)			<5		<5						
55. Sodium (mg/l)	850	640	830	800	850						
56. Sodium Adsorption Ratio	15	12	16	15	16						
57. Sodium ( )	76	72	78	76	78						
58. Solids, Dissolved (mg/l)	2760	2240	2630	2650	2880						
59. Solids, Dissolved T/D	15.2	21.4	--	15.3	--						
60. Solids, Dissolved T/Ac-Ft	3.75	3.05	3.56	3.60	3.97						
61. Solids, Suspended											
62. Strontium (ug/l)	3100	3200	2700	--	--	3500					
63. Sulfate (mg/l)	570	520	570	630	620						
64. Sulfide (mg/l)			0.6								
65. Temperature (°C)	0	1.0	1.0	16.0	27.0						
66. Tin (ug/l)			<50			<50					
67. Titanium (ug/l)			<20			<30					
68. Turbidity (JTU)											
69. Vanadium (ug/l)			<40			<50					
70. Zinc (ug/l)			0			0					
71. Zirconium (ug/l)			<100			<100					
72. Calcium (mg/l)	35	39	34	32	7.4						
73. Complete Element Span											
74. Radioactivity											
Gross Alpha (ug/l)			<24			51.1					
Radium 226*											
Gross Beta			14			<7.4					
Thorium 230**											
Uranium**											
75. Total Organic Carbon (mg/l)	13.4										
If TOC >10 mg/liter, then											
Nitrogen (Base Extraction)											
Organic Carbon, Dissolved	6.9	11	12	--	4.3						
Organic Carbon, Suspended		2.4	1.1	1.0	--						
Phenols											
Sulfur (Acid Extraction)											
76. Total Ortho-Phosphorous (mg/l)	.09	.07	.09	.03	.0						
77. Phosphate	.49	1.4	.37	.74	.21						
78. Phosphorus, Dissolved											

The continous mean conductivity for Corral Gulch east of Tract C-a averaged about 1300 umhos/cm during this reporting period and had peaks of 1650 umhos/cm in early June. The average value for this period is somewhat higher, 200 umhos/cm, than for the previous reporting period.

Continuous mean conductivity readings for Corral Gulch south of 84 Mesa were disrupted by periods when equipment was malfunctioning. The average from mid-April to June was about 1500 umhos/cm. This value is similar to data collected for the previous quarter. A peak value of 3300 umhos/cm for the reporting period was reached in late June.

Sparse data on mean conductivity was retrieved from the Yellow Creek station near White River. Values ranged from 1150 umhos/cm to over 2200 umhos/cm.

A good correlation between changes in stream flow and conductivity was not consistently possible due to missing data.

Mean temperature data for the four perennial stream gaging stations is presented in RBOSP Progress Report 8, Interpretive Text. The data for two of these stations is fairly continuous with only minor periods of no data, while two, Corral Gulch near West line Tract C-a, and Yellow Creek near White River, have several months of no data. The overall mean temperature for this period is a warming one, reflecting seasonal temperature increases. However, short period decreases were noted in May and June for three of the stations.

Instantaneous boron and fluoride analyses were made on samples from the following stations:

- Box Elder Gulch near west line Tract C-a
- Corral Gulch east of Tract C-a
- Corral Gulch south of 84 Mesa
- Corral Gulch near the west line of Tract C-a
- Yellow Creek near White River

Values have remained relatively stable since mid-April for both boron and fluoride. Water samples from the station on Yellow Creek near White River had the highest concentrations of boron and fluoride, averaging 0.7 mg/l and 2.6 mg/l respectively. Values from the other stations averaged from 0.2 to 0.4 mg/l for fluoride, and less than 0.1 to 0.2 mg/l for boron.

Data reported for this period conform with previous values for the respective stations. Yellow Creek continues to show higher concentration for most constitutents, and Box Elder Gulch continues to show lower concentrations compared to other stations. Constituents that show fairly similar values over the five stations include arsenic, dissolved oxygen, fluoride and lithium.

1.2.2.3 Precipitation

Precipitation data is collected by the USGS using three different types of rain gages, they are: the storage type rain gage; recording type gage, which measures precipitation daily; and the rainfall intensity gage; which records the time of each event and amount of precipitation during successive five minute time increments. Table 1.2-9 is a summary of the precipitation data for the quarterly reporting period. Additional data are presented in the Interpretative Text and Raw Data portions of this progress report.

Precipitation data for this reporting period indicates that a relatively dry period occurred between June 20 and July 10, 1976. The greatest amount of precipitation occurred at the Cathedral Bluffs Station and the minimum at the Yellow Creek gaging stations.

1.2.3 Alluvial Aquifers

Fifteen alluvial aquifer test holes have been drilled on and around Tract C-a and the proposed processed shale and overburden disposal site on 84 Mesa. The holes which encountered water at the time they were drilled are: G-S S-7, S-8, S-11, S-12, S-19, S-22, S-23 and S-24. Continuous water level recorders (Stevens Type F) were installed at G-S S-7, S-8, S-11, and S-12. Water samples for standard chemical analysis are to be collected in February, July, November and monthly during the snowmelt flash flood seasons, April through September. A data collection schedule for alluvial holes is shown in Table 1.2-10.

1.2.3.1 Water-Level Data

Water level data for the alluvial holes are summarized in Table 1.2-11. During the quarter the average water level changes was 1.2 feet. The only well showing an exception to this trend was G-S S-12 which had a consistent rising water level trend.

Table 1.2-9

PRECIPITATION SUMMARY
(Inches)
1976

Recording Type Rain Gage Locations	JUNE			JULY			AUGUST		
	Maximum	Total	Number of Days	Maximum	Total	Number of Days	Maximum	Total	Number of Days
Stake Springs Draw near confluence with Corral Gulch	0.73	1.79	7	0.38	0.97	6	0.09	0.42	7
Yellow Creek near White River	0.41	0.82	4	0.50	1.08	7	0.24	0.66	6
Cathedral Bluffs located in NW-1/4, NW-1/4, Sec. 14, T2S, R100W	0.65	1.74	5	0.87	2.04	7	0.45	1.09	6

APPROXIMATE MONTHLY TOTAL

Storage Type Rain Gage Locations	JUNE	JULY	AUGUST
Dry Fork near west line Tract C-a	2.01	0.88	1.44
Box Elder Gulch near west line Tract C-a	2.28	0.73	1.35
Corral Gulch near west line Tract C-a	1.79	0.71	0.83

TABLE 1.2-10

DATA COLLECTION SCHEDULE FOR ALLUVIAL HOLES

Monthly

Water Levels Measured

February, July, November Plus Snowmelt-Flash Flood Seasons (April to September)

Water Samples Analyzed For:

- Alkalinity
- Ammonia
- Boron
- Bicarbonate
- Calcium
- Carbonate
- Chloride
- Conductance
- Dissolved Organic Carbon
- Dissolved Solids
- Fluoride
- Iron
- Magnesium
- Manganese
- Kjeldahl Nitrogen
- Nitrate plus Nitrite
- Orthophosphate
- Dissolved Phosphate Potassium
- Silica
- Sodium
- Sulfate
- Color
- Odor
- pH
- Temperature

February, July, November

Water Samples Analyzed for:

- DO
- Bromide
- Cyanide
- BOD
- COD
- Phenols
- Sulfide
- Radioactivity
  - Gross Alpha
    - 4 pci/l
    - ^{226}Ra
  - Gross Beta
    - 100 pci/l
    - Sr^{90}
    - Ce^{137}
- Ba
- Be
- Bi
- Ge
- Ga
- Ni
- Sr
- Ti
- V
- Zr
- Al
- As
- Cd
- Cr
- Cu
- Pb
- Li
- Mo
- Hg
- Se
- Sr
- Zn

July or August

Samples Analyzed for:

- Fecal Coliform
- Total Coliform
- MBAS

TABLE 1.2-11

ALLUVIAL HOLES

COMPARATIVE WATER DEPTHS

	June - August Depth in Feet		
Hole No.	Maximum	Minimum	Quarterly* Change
G-S S- 6			Dry
G-S S- 7	24.57	22.17	-2.40
G-S S- 8	35.77	29.02	-6.75
G-S S-11	44.78	43.83	-0.03
G-S S-12	33.71	28.11	+5.60
G-S S-13			Dry
G-S S-14			Dry
G-S S-15			Dry
G-S S-16			Dry
G-S S-17			Dry
G-S S-18			Dry
G-S S-19	58.18	53.24	-4.94
G-S S-22	65.91	65.06	- .51
G-S S-23	29.51	28.62	- .89
G-S S-24	6.95	6.25	- .44

* Quarterly change is the difference between the first measurement of the quarter and the last measurement made during the quarter. The signs (+ or-) designate whether the water level has risen (+) or fallen (-) from the first of the quarter to the end of the quarter.

1.2.3.2 Water Quality

Field measurements of conductivity showed an average quarterly increase of 220 umhos/cm in holes G-S S-7, S-11, S-12, S-22, and S-24, with an average decrease of 250 umhos/cm observed in holes G-S S-8, S-19 and S-23.

Water temperature decreased in wells G-S S-11, S-12, S-19, S-22, and S-23, while increases were recorded for G-S S-7, S-8, and S-24.

Measurements of pH remained between 6.1 and 6.9 for all wells. Well G-S S-23 showed a slight decline from the previous quarter, while all others tended to change little or increase slightly within this range.

Overall water quality of the alluvial aquifer remained relatively stable. There were no significant increases for any constituents compared to the last reporting period. Sodium, sulfate, and potassium had higher maximum values but averages showed relatively little change. Tables 1.2-12 and 1.2-13 are summaries of the water quality analyses since March 1975.

1.2.7 Deep Aquifer Monitoring

The deep aquifer monitoring program was initiated in December 1974. The program includes the measurements of water levels and collecting of water samples for analyses to determine water quality. Water samples were collected monthly from March through August 1975. Following that six month period of collecting monthly samples, sample collecting was placed on a semi-annual schedule and static water levels on a monthly schedule. The data collection schedule for deep aquifers is shown in Table 1.2-14. The last samples were collected from the deep aquifers in March of 1976 and reported in Progress Report 7. Some analyses not finished in time for inclusion in Progress Report 7 are included in this Progress Report.

1.2.7.1 Deep Aquifer Water Levels

Water level data from October, 1975 through August, 1976 are included in the Raw Data Volume of this report. Tables 1.2-15 and 1.2-16 show the water level for the upper and lower aquifers respectively.

The upper aquifer water levels had a general rising trend, with few exceptions. Rising water levels were recorded for

TABLE 1.2-12
SUMMARY OF WET CHEMICAL ANALYSIS
ALLUVIAL AQUIFER
Values in mg/l
MARCH 1975 THROUGH AUGUST 1976

Item	Low	High	Average	# Items Averaged	Std. Dev.
Alkalinity	310	1505	474.180	134	120.858
Aluminum	< 0.100	1.200	0.140	10	.375
Ammonia	0.030	6.4	0.537	107	0.883
Arsenic	< 0.010	< 0.100		111	0.001
Barium	< 1.000	< 1.000		97	
Bicarbonate	360	780.000	563.134	134	100.734
Boron	< 0.010	27.000	1.103	126	2.871
Cadmium	< 0.010	< 1.100	0.031	111	0.111
Calcium	28.000	240.000	99.463	134	35.876
Carbonate	< 0.010	605.000	10.737	133	53.378
Chloride	1.300	71.000	17.399	134	8.005
Chromium	< 0.010	0.200	0.008	110	0.036
Conductivity (umhos/cm)	860.000	2370.000	1549.480	134	359.286
Copper	< 0.010	8.000	0.481	111	1.179
Cyanide	< 0.010	0.200	0.004	112	0.020
Dissolved Solids	640.000	2090.000	1191.978	134	291.505
Fluoride	< 0.100	1.200	0.335	133	0.181
Gross Alpha (pci/l)	1.400	31.000	11.980	85	6.720
Gross Beta (pci/l)	1.000	35.000	13.346	30	10.009
Hardness (total)	280.000	820.000	606.875	120	141.009
Iron	< 0.050	28.000	5.573	134	5.957
Lead	0.010	13.000	0.346	110	1.239
Magnesium	3.700	150.000	87.179	134	36.417
Manganese	< 0.050	27.000	2.705	126	4.374
Mercury	< 0.001	< 0.010		111	
Nickel	0.010	0.200	0.074	97	0.057
Nitrate	< 0.100	165.000	6.434	134	15.154
pH	< 6.000	7.200	6.425	132	0.645
Phosphate	< 0.010	1.600	0.059	134	0.187
Selenium	< 0.010	< 0.100		111	
Silicon Dioxide	16.000	44.000	30.134	134	5.366
Silver	< 0.010	< 0.100	0.007	96	0.013
Sodium	72.000	450.000	188.515	134	59.044
Sulfate	145.000	1000.000	457.649	134	158.339
Zinc	0.100	13.000	0.669	109	1.404
Potassium	< 1.000	14.000	4.942	36	3.790
Lithium	< 0.100	0.100	0.014	14	0.036
Total Organic Carbon	2.900	292.000	47.858	98	60.328
Nitrite -N	< 0.010	0.100	0.004	29	0.019
Bromide	0.100	0.900	0.717	6	0.306
Chemical Oxygen Demand	2.500	85.000	18.893	14	20.774
Phenols	< 0.001	< 0.001		14	
Kjeldahl N	< 0.100	8.800	1.811	37	19.973
Beryllium	< 0.020	2.500	0.612	8	0.884
Ortho Phosphate	< 0.100	1.000	0.055	31	0.182
Ammonia -N	< 0.100	5.300	0.753	15	1.378
Dissolved Organic Carbon	2.000	3.000	2.125	8	0.354
MBAS	< 0.010	< 0.010		6	
Total Coliform	< 10.000	250.000	81.429	7	91.911
Fecal Colifrom	< 10.000	40.000	8.571	7	15.736

< = less than

TABLE 1.2-13
SUMMARY OF QUALITATIVE SPECTROGRAPHIC ANALYSIS
ALLUVIAL AQUIFER
Values in mg/l
MARCH 1975 THROUGH AUGUST 1976

Item	Low	High	Average	# Items Averaged	Std. Dev.
Aluminum	0.005	5.000	0.487	111	0.987
Antimony	---	---	---	0	---
Arsenic	---	---	---	0	---
Barium	0.001	0.050	0.008	49	0.013
Beryllium	0.001	0.001	0.001	5	0.000
Bismuth	---	---	---	0	---
Boron	0.010	0.500	0.344	111	0.179
Cadmium	---	---	---	0	---
Calcium	10.000	Major	10.000	6	0.000
Cerium	---	---	---	0	---
Cesium	0.001	0.001	0.001	1	0.000
Chromium	---	0.020	0.004	17	0.006
Cobalt	0.001	0.001	0.001	4	0.000
Columbium	---	---	---	0	---
Copper	0.001	0.050	0.014	110	0.014
Dysprosium	---	---	---	0	---
Erbium	---	---	---	0	---
Europium	---	---	---	0	---
Gadolinium	---	---	---	0	---
Gallium	0.001	0.010	0.004	6	0.005
Germanium	0.001	0.001	0.001	1	0.000
Gold	---	---	---	0	---
Hafnium	---	---	---	0	---
Holmium	---	---	---	0	---
Indium	---	---	---	0	---
Iridium	---	---	---	0	---
Iron	0.010	5.000	0.280	11	0.751
Lanthanum	---	---	---	0	---
Lead	0.001	0.500	0.036	45	0.083
Lithium	0.001	0.100	0.007	85	0.015
Lutetium	---	---	---	0	---
Mangesium	5.000	Major	2228.111	9	4405.680
Manganese	0.001	0.500	0.066	104	0.119
Mercury	---	---	---	0	---
Molybdenum	0.001	0.050	0.007	71	0.010
Neodymium	---	---	---	0	---
Nickel	0.001	0.070	0.011	7	0.026
Osmium	---	---	---	0	---
Palladium	---	---	---	0	---
Platinum	---	---	---	0	---
Potassium	0.010	2.000	0.585	111	0.505
Praseodymium	---	---	---	0	---
Radium (pci/l)	0.100	1.200	0.341	61	0.233
Rhenium	---	---	---	0	---
Rhodium	---	---	---	0	---
Rubidium	---	---	---	0	---
Ruthenium	---	---	---	0	---
Samarium	---	---	---	0	---
Scandium	---	---	---	0	---
Selenium	---	---	---	0	---
Silicon	2.000	Major	4.972	109	2.651
Silver	---	0.100	0.008	34	0.024
Sodium	1.000	Major	6.239	88	2.758
Strontium	0.010	0.100	0.105	108	0.089
Tantalum	---	---	---	0	---
Terbium	---	---	---	0	---
Thallium	---	---	---	0	---
Thorium	---	---	---	0	---
Thulium	---	---	---	0	---
Tin	0.001	0.001	0.001	15	0.000
Titanium	0.001	1.000	0.029	91	0.118
Tungsten	---	---	---	0	---
Uranium	---	---	---	0	---
Vanadium	0.001	0.020	0.007	10	0.008
Ytterbium	0.001	0.001	0.001	5	0.000
Yttrium	0.010	0.020	0.010	5	0.004
Zinc	0.001	0.020	0.005	44	0.006
Zirconium	0.010	0.010	0.010	2	0.000

--- Less than minimum detectable amount
Major - Concentration too large to quantify (see wet chemical analysis)

TABLE 1.2-14

DATA COLLECTION SCHEDULE FOR DEEP AQUIFER

Monthly

Water Levels Measure

Semi-Annually

Water Sample Analyzed For:

- Alkalinity
- Aluminium
- Ammonia
- Arsenic
- Ba
- Be
- Bi
- Bicarbonate
- Br
- B
- Dissolved Organic Carbon
- Calcium
- Carbonate
- Cd
- Chloride
- Cr
- Cu
- Cyanide
- COD
- Dissolved Solids
- Ge
- Ga
- Fluoride
- Iron
- Lead
- Li
- Mg
- Mn
- Hg
- Mo
- Ni
- Nitrate plus Nitrite
- Phenols
- Dissolved Phosphate
- Pottassium
- Se
- Silica
- Na
- Sr
- Sulfate
- Sulfide
- Ti
- V
- Zr
- Zn
- Color
- Odor
- pH
- Temperature
- Conductance

- Radioactivity
  - Gross Alpha
    - 4 pci/l ^{226}Ra
  - Gross Beta
    - 100 pci/l
    - ^{90}Sr
    - ^{137}Ce

TABLE 1.2-15
UPPER AQUIFER

WATER LEVEL

October, 1975 thru August, 1976

Below Ground Surface (ft.)

	9 Oct.	20 Nov.	12 Dec.	28 Jan.	17 Feb.	29 Mar.	14 April	21 May	23 June	30 July	28 Aug.
AM 2A	389.45	387.63	386.41	385.17	384.34	383.19	382.50	381.85	--	379.40	379.09
AM 3	33.57	33.45	33.11	33.23	33.04	32.79	31.60	30.04	28.72	29.17	30.06
CE 702	52.40	52.30	52.39	52.64	52.65	52.80	52.66	53.02	54.50	53.38	53.70
CE 707	259.79	258.76	258.11	257.25	256.64	242.22	250.32	250.60	250.97	252.03	252.00
CE 708	48.87	50.60	49.86	51.78	51.80	51.30	47.72	44.81	46.43	44.30	46.91
CE 709	39.84	37.02	36.14	35.90	35.69	35.50	34.88	35.00	34.48	33.90	38.84
G-S 1	244.68	245.27	245.59	246.19	246.53	246.28	244.53	243.26	242.57	241.92	242.10
G-S 2-3	103.49	102.75	102.35	102.25	101.97	100.87	100.28	99.86	99.26	99.06	99.26
G-S 4-5	75.05	74.77	74.29	74.36	74.01	73.48	72.98	72.86	73.33	72.42	72.47
G-S 6	55.62	55.54	55.42	55.50	55.45	55.27	54.95	55.22	55.10	55.20	55.61
G-S 9	311.43	312.69	316.33	319.29	319.95	321.42	320.94	317.03	316.45	317.23	319.63
G-S 10	340.35	340.11	--	339.75	339.60	339.36	339.14	339.48	339.50	339.37	339.62
G-S 11	460.35	459.67	459.00	458.76	458.40	457.72	456.95	456.42	455.46	454.99	455.35
G-S 12	388.30	387.60	386.97	386.55	386.24	385.41	384.67	382.79	382.83	381.86	382.91
G-S 13	382.62	382.19	381.68	381.72	381.45	381.04	380.97	380.41	380.11	380.12	378.47
G-S 15	274.73			273.56	273.41	272.99	272.83	272.69	274.76	272.58	272.49
G-S M-1	620.64	621.13	--	619.10	618.77	618.71	625.57	619.31	619.40	619.95	620.26
G-S M-2	231.22	230.68	229.75	228.94	228.23	225.76	225.39	225.36	224.01	221.28	223.13
G-S M-3	21.59	21.96	20.32	19.16	19.21	18.57	17.50	17.72	18.75	18.58	18.46
G-S M-4	491.80	491.95	491.56	492.04	492.08	492.25	--	492.77	492.94	493.26	491.60
G-S M-5	235.73	235.81	235.24	235.70	235.64	235.51	235.38	235.75	235.80	235.94	235.90
TO-1	21.80	20.65	20.41	20.95	20.83	20.53	20.13	22.35	22.46	22.30	22.73
TO-2	113.36	113.36	122.96	112.93	112.73	112.57	112.18	113.81	113.70	111.32	111.44

-- Water levels not collected due to poor weather conditions making access to hole difficult or because problems with monitoring hole and equipment.

TABLE 1.2-16
LOWER AQUIFER

WATER LEVEL

October, 1975 thru August, 1976

Below Ground Surface (ft)

	9 Oct.	20 Nov.	12 Dec.	28 Jan.	17 Feb.	29 Mar.	14 April	21 May	23 June	30 July	28 Aug.
AM 2A	636.67	637.70	638.08	639.71	640.11	641.15	641.63	643.56	--	645.47	645.51
AM 3	310.40	311.27	311.56	313.34	313.73	314.65	315.31	316.90	317.67	318.80	319.50
CE 702	40.48	41.21	41.25	43.00	43.41	44.21	44.64	45.81	48.50	47.30	47.97
CE 707	567.51	568.70	569.21	570.67	571.04	572.19	572.53	--	573.00	573.81	574.78
CE 708	297.88	298.97	299.27	300.84	301.22	302.97	303.06	303.83	304.59	306.74	307.52
CE 709	154.31	155.55	154.92	157.62	158.63	158.87	159.60	160.82	160.61	162.63	163.23
G-S 1	602.65	602.43	602.13	602.13	601.70	601.64	601.58	601.91	601.76	601.67	602.36
G-S 2-3	254.92	255.98	256.61	258.03	258.32	259.43	259.81	261.05	261.79	262.79	263.66
G-S 4-5	98.31	99.55	100.09	100.57	101.95	102.89	103.40	104.46	105.12	--	105.74
G-S 6	44.06	45.88	46.26	47.72	48.12	49.01	49.45	50.65	51.29	52.41	52.89
G-S 9	513.25	514.31	514.68	516.10	516.22	517.19	517.96	517.56	518.14	518.51	519.65
G-S 10	389.69	380.81	--	392.76	393.06	394.01	394.57	396.13	396.89	398.04	398.71
G-S 11	721.76	723.02	723.36	725.51	725.53	726.65	727.18	727.63	728.46	729.60	730.46
G-S 12	649.79	649.76	650.08	651.97	652.30	653.36	653.92	655.54	656.45	659.06	656.86
G-S 13	573.82	574.98	575.36	577.08	577.34	578.39	578.96	580.40	581.58	582.80	579.40
G-S 15	363.99	365.27	365.64	367.28	367.64	368.71	369.24	370.79	371.79	372.69	373.41
G-S M-1	822.20	824.61	--	824.87	825.18	825.84	826.59	829.59	830.34	831.35	831.79
G-S M-2	354.96	355.03	354.44	355.14	354.69	354.60	354.73	353.64	355.46	355.31	355.76
G-S M-3	139.89	140.67	139.25	140.34	139.69	139.64	145.02	140.27	140.18	140.67	140.97
G-S M-4	562.50	563.58	563.95	565.32	565.65	566.55	--	--	--	571.65	568.23
TO-1	127.21	128.40	128.77	130.41	130.81	131.78	132.31	133.54	134.56	135.78	136.28
TO-2	356.68	357.83	358.31	359.62	359.95	361.01	360.93	362.93	363.57	364.64	365.30

-- Water levels not collected due to poor weather conditions making access to hole difficult or because problems with monitoring hole and equipment.

the central area of the southern portion of the tract and for well TO-2 in the northern portion of the tract. The average water level rise per month was 0.70 ft. during this recording period.

Water levels in the north part of the tract were relatively stable except for well TO-2 which had a rise of almost 2.5 feet, and well CE-709 which had a decline of almost 5 ft.

Water levels in the lower aquifer have decreased 1 to 2 ft. across the tract for this period, with the exception of well G-S S-13 where an increase of 3.4 feet was noted from July to August.

1.2.7.2 Deep Aquifer Water Quality

Progress Report 7 reported that samples were not collected from wells G-S 8, 10 and M-4 due to problems associated with those holes. These problems have been identified and corrected, with the exception of G-S 8 which was found to be plugged at a depth of approximately 630 feet. A request has been submitted by Rio Blanco Oil Shale to the Project Area Oil Shale Supervisor to abandon GS-8 as a monitoring hole.

The analyses of samples from the deep aquifer monitor holes are reported in the Raw Data Volume of this Progress Report, and summarized in Tables 1.2-17 and 1.2-18 of this report.

Water quality in the upper and lower aquifer remained relatively stable with few exceptions. In the upper aquifer the high values for ammonia, calcium, carbonate, chloride and chromium were higher but averages remained relatively unchanged. Potassium and phosphate showed extremely higher values for the high reading as compared to last quarter, therefore, increasing the average for the quarter.

The high values for the lower aquifer were likewise much higher with averages remaining fairly stable except for dissolved solids, nitrate, and fluoride which had higher averages than last quarter. Iron had exceptionally high maximum values, with essentially no change in the average values.

1.2.8 Hydrologic Program Summary and Analysis

Hydrologic data collected during the period June through August is reported in Progress Report 8, Raw Data Volume. This section summarizes this data under three main categories: Surface Water, Precipitation, Alluvial Aquifers, and Deep Aquifers.

TABLE 1.2-17

SUMMARY OF SPECTROGRAPHIC ANALYSIS MONITORING PROGRAM

UPPER AND LOWER AQUIFER
TRACT C-a and VICINITY
Values in mg/l

March 1975 to August 1976

	Lower Aquifer					Upper Aquifer				
Item	Low	High	Average	# Items Avg'd.	Std. Dev.	Low	High	Average	# Items Avg'd.	Std. Dev.
Aluminum	0.001	5.000	0.125	196	0.390	0.001	1.000	0.141	218	0.204
Antimony	0.200	0.200	0.200	1	0.000	---	---	---	0	---
Arsenic	---	---	---	0	---	---	---	---	0	---
Barium	0.001	0.100	0.016	28	0.032	0.001	0.050	0.006	26	0.010
Beryllium	---	---	---	0	---	---	---	---	0	---
Bismuth	---	---	---	0	---	---	---	---	0	---
Boron	0.050	Major	0.437	195	0.622	0.020	5.000	.355	218	0.412
Cadmium	Major	Major		0		Major	Major		0	
Calcium	0.100	Major'	6.836	36	4.341	1.000	Major	7.158	19	3.976
Cerium	---	---	---	0	---	---	---	---	0	---
Cesium	---	---	---	0	---	---	---	---	0	---
Chromium	0.001	0.010	0.005	2	0.006	---	0.050	0.010	13	0.013
Cobalt	---	---	---	0	---	---	---	---	0	---
Columbium	---	---	---	0	---	---	---	---	0	---
Copper	0.001	0.100	0.007	172	0.010	---	0.050	0.008	179	0.010
Dysprosium	---	---	---	0	---	---	---	---	0	---
Erbium	---	---	---	0	---	---	---	---	0	---
Europium	---	---	---	0	---	---	---	---	0	---
Gadolinium	---	---	---	0	---	---	---	---	0	---
Gallium	---	---	---	0	---	---	---	---	0	---
Germanium	---	---	---	0	---	---	---	---	0	---
Gold	---	---	---	0	---	---	---	---	0	---
Hafnium	---	---	---	0	---	---	---	---	0	---
Holmium	---	---	---	0	---	---	---	---	0	---
Indium	---	---	---	0	---	---	---	---	0	---
Iridium	---	---	---	0	---	---	---	---	0	---
Iron	0.005	5.000	0.112	196	0.510	0.010	1.000	0.102	215	0.177
Lanthanum	---	---	---	0	---	---	---	---	0	---
Lead	---	0.500	0.029	39	0.084	0.001	0.500	0.340	52	0.080
Lithium	0.001	5.000	0.049	144	0.416	0.001	0.500	0.026	144	0.058
Lutetium	0.100	0.010	0.010	1	0.000	0.001	0.010	0.005	2	0.006
Magnesium	0.100	Major	3.967	36	3.098	0.100	Major	6.277	22	4.054
Manganese	0.001	0.200	0.016	156	0.031	0.001	1.000	0.028	162	0.084
Mercury	---	---	---	0	---	---	---	---	0	---
Molybdenum	0.001	0.100	0.008	97	0.015	0.001	0.500	0.015	111	0.067
Neodymium	0.090	0.090	0.090	1	0.000	---	---	---	0	---
Nickel	0.001	0.001	0.001	1	0.000	0.001	0.010	0.005	5	0.005
Osmium	---	---	---	0	---	---	---	---	0	---
Palladium	---	---	---	0	---	---	---	---	0	---
Platinum	---	---	---	0	---	---	---	---	0	---
Potassium	0.010	Major	1.207	187	1.496	0.010	Major	1.016	199	1.446
Praseodymiun	---	---	---	0	---	---	---	---	0	---
Radium (pci/l)	0.090	2.100	0.417	43	0.386	0.100	0.800	0.194	31	0.156
Rhenium	---	---	---	0	---	---	---	---	0	---
Rhodium	---	---	---	0	---	---	---	---	0	---
Rubidium	---	---	---	0	---	---	---	---	0	---
Ruthenium	---	---	---	0	---	---	---	---	0	---
Samarium	---	---	---	0	---	---	---	---	0	---
Scandium	---	---	---	0	---	---	---	---	0	---
Selenium	---	---	---	0	---	---	---	---	0	---
Silicon	0.500	Major	5.533	195	3.841		50.000	9.234	218	8.435
Silver	---	0.001	0.001	14	0.000	---	0.001		19	0.000
Sodium	0.100	Major	7.490	92	2.716	2.000	Major	7.385	104	2.897
Strontium	0.001	Major	0.113	178	0.124	0.001	1.000	.131	183	0.121
Tantalum	---	---	---	0	---	---	---	---	0	---
Terbium	---	---	---	0	---	---	---	---	0	---
Thallium	---	---	---	0	---	---	---	---	0	---
Thorium	---	---	---	0	---	---	---	---	0	---
Thulium	---	---	---	0	---	---	---	---	0	---
Tin	---	0.001	0.001	2	0.001	0.001	0.001	0.001	1	0.000
Titanium	0.001	0.050	0.004	80	0.006	0.001	0.150	0.010	116	0.023
Tungsten	---	---	---	0	---	---	---	---	0	---
Uranium	1.500	1.500		1	0.000	---	---	---	0	---
Vanadium	---	---	---	0	---	0.001	0.100	0.027	16	0.027
Ytterbium	---	---	---	0	---	---	---	---	0	---
Yttrium	---	---	---	0	---	---	---	---	0	---
Zinc	0.001	0.500	0.032	42	0.110	0.001	0.500	0.026	51	0.077
Zirconium	---	---	---	0	---	---	---	---	0	---

--- Less than minimum detectable amount
Major - Concentration too large to quantify (see wet chemical analysis)

TABLE 1.2-18

SUMMARY OF WET CHEMICAL ANALYSIS MONITORING PROGRAM
UPPER AND LOWER AQUIFER
TRACT C-a AND VICINITY
Values in mg/l
MARCH 1975 to AUGUST 1976

Item	Lower Aquifer					Upper Aquifer				
	Low	High	Average	# Items Averaged	Std. Dev.	Low	High	Average	# Items Averaged	Std. Dev.
Alkalinity	- 0.100	1048.000	896.067	202	1071.363	- 0.100	2390.000	513.837	184	462.706
Aluminum	- 0.010	1.600	0.121	47	0.272	- 0.010	2.200	0.176	46	0.387
Ammonia	- 0.010	9.600	0.653	172	0.947	- 0.100	10.600	0.618	187	1.047
Arsenic	- 0.010	0.050	0.001	192	0.005	- 0.010	0.200	0.003	198	0.018
Barium	- 0.100	1.000	0.006	168	0.007	- 0.100	- 1.000		137	
Bicarbonate	- 0.100	11800.000	1042.439	207	1204.645	- 0.100	2760.000	604.606	226	485.724
Boron	- 0.010	25.000	1.716	190	3.198	- 0.010	4.800	0.672	169	0.974
Bromide	- 0.020	0.400	0.030	22	0.089	- 0.020	0.500	0.083	21	0.142
Chemical Oxygen Demand	- 1.300	92.000	28.505	22	23.209	- 0.900	400.000	82.671	21	100.460
Cadmium	- 0.001	0.030	0.002	193	0.005	- 0.001	0.100	0.002	182	0.009
Calcium	0.800	515.000	35.885	207	69.743	- 0.010	780.000	63.654	226	68.821
Carbonate	- 0.010	3160.000	94.680	207	248.912	- 0.010	1190.000	33.395	225	93.509
Chloride	- 1.000	205.000	33.921	207	38.773	- 1.000	240.000	23.774	226	31.371
Chromium	- 0.010	- 0.050	0.002	188	0.007	- 0.100	0.500	0.007	183	0.041
Conductivity (umhos/cm)	760.000	15800.000	2191.531	205	1873.355	675.000	6200.000	1527.262	225	768.910
Copper	- 0.010	0.300	0.016	193	0.046	- 0.010	0.800	0.024	182	0.096
Cyanide	- 0.010	0.800	0.005	187	0.059	- 0.010	0.100	0.001	157	0.010
Dissolved Oxygen Demand	- 1.000	73.000	10.612	144	8.088	- 1.000	50.000	9.861	135	7.228
Dissloved Solids	430.000	12200.000	1507.597	206	1235.199	425.000	3140.000	1139.318	226	504.789
Fluoride	0.030	120.000	13.682	208	19.727	0.060	80.000	3.906	226	10.120
Gross Alpha (pci/l)	0.100	86.000	6.359	135	9.835	0.200	29.000	5.081	117	4.881
Gross Beta (pci/l)	3.000	830.000	53.100	50	123.148	2.000	73.000	21.613	31	17.890
Hardness (total)	20.000	1260.000	245.443	185	213.795	16.000	1870.000	379.458	205	237.825
Iron	- 0.050	33.000	2.842	207	4.402	0.005	18.000	3.803	210	4.614
Lead	0.002	26.000	0.613	193	2.396	0.002	3.800	0.339	182	0.531
Lithium	- 0.100	0.200	0.050	22	0.080	- 0.100	- 0.500	0.009	23	0.029
Magnesium	- 1.000	140.000	36.349	207	31.092	- 0.100	200.000	53.279	225	33.300
Manganese	- 0.010	0.800	0.073	201	0.106	- 0.100	1.000	0.140	198	0.172
Mercury	- 0.001	- 0.010	0.000	189	0.000	- 0.001	0.045	0.000	185	0.003
Nickel	- 0.001	0.100	0.023	166	0.019	- 0.001	0.200	0.027	137	0.028
Nitrate	- 0.010	55.000	0.696	207	3.960	- 0.010	7.000	0.523	226	0.940
Nitrate -N	- 0.020	- 0.100		21		- 0.020	- 0.020		21	
pH	6.000	12.200	7.373	205	0.806	6.000	10.200	7.044	226	0.656
Phenols	- 0.001	1.000	0.045	22	0.213	- 0.001	- 0.001		21	
Phosphate	- 0.010	2.400	0.048	194	0.207	- 0.010	9.200	0.163	185	0.895
Potassium	- 1.000	84.000	6.515	27	16.905	- 0.100	93.000	8.835	62	20.432
Selenium	- 0.001	- 0.100	0.000	193	0.000	- 0.001	- 0.100		199	
Silicon Dioxide	- 0.100	60.000	11.405	207	9.966	- 0.100	58.000	25.610	226	14.269
Silver	- 0.001	0.110	0.003	166	0.015	- 0.001	0.100	0.007	137	0.019
Sodium	86.000	5290.000	512.807	207	542.042	32.000	1170.000	271.641	226	211.380
Sulfate	3.500	740.000	210.717	207	175.211	- 4.000	900.000	336.580	226	170.267
Sulfide	- 0.010	2.400	0.664	25	0.703	0.030	40.000	2.828	40	7.280
Zinc	- 0.001	68.000	1.233	193	6.031	- 0.010	15.000	0.691	173	1.472

(-) Less than detectable limit given.

1.2.8.1 Surface Water

Of the eleven stream gaging stations only five reported flow during this reporting period. The five stations that had relatively continuous flows for the period were: Box Elder Gulch near west line Tract C-a, Corral Gulch east of Tract C-a, Corral Gulch south of 84 Mesa, Corral Gulch near west line Tract C-a, and Yellow Creek near White River.

Water quality analysis were performed by the USGS from the following stream gaging stations: Box Elder Gulch near the west line of the tract; Corral Gulch near the west line of the tract; Corral Gulch east of the tract; Corral Gulch south of 84 Mesa; and Yellow Creek near the White River. In general, data reported for this period conform with previous stations values. Yellow Creek continues to show substantially higher concentrations than other stations for most constituents. Box Elder Gulch station near west line tract has lower concentrations than the other five stations. Certain constituents show substantial variation for this calendar year for each station. These include alumium, aromatics (polycyclic), Kjeldahl nitrogen, ammonia nitrogen, organic carbon, and phosphate. Constitutents that show fairly similar values for the five stations include arsenic, dissolved oxygen, fluoride and lithium.

1.2.8.2 Precipitation

The recording type precipitation gages near Cathedral Bluffs, Stake Springs Draw, and Yellow Creek indicated that wet periods occurred around May 8, May 20, mid-June, and about July 18. A very dry period was noted in late June and early July. In general, greatest intensity of precipitation events recorded were at the Cathedral Bluffs station. Of the some 30 precipitation events recorded at each station over the tract, the Cathedral Bluffs station averaged 0.24 inch per event with a maximum value of 0.87 inches per event. The Yellow Creek gage recorded an average intensity of 0.10 inch per event with a maximum value of 0.41 inch per event. Storage type precipitation gages from Dry Fork, Box Elder Gulch, and Corral Gulch were generally correlative for relative amounts of precipitation over the same time period. Widespread events occurred at all stations.

1.2.8.3 Alluvial Aquifers

During this reporting period the water levels recorded in the alluvial holes declined an average of 1.2 feet, except for well G-S S-12 which had a consistent rising trend.

Conductivity and temperature readings varied throughout the area with both increases and decreases being recorded. Holes G-S S-7, S-11, S-12, S-22, and S-25 had an average quarterly increase of 220 umhos/cm, whereas holes G-S S-8, S-19 and S-23 had average decreases of 350 umhos/cm.

Overall water quality of the alluvial aquifer remained relatively stable. Calcium and carbonate concentration increased by 50% to 100% as compared to the previous reporting period, while iron, boron and nitrate significantly decreased.

1.2.8.4 Deep Oil Shale Aquifers

The deep oil shale aquifers, upper and lower, are monitored semi-annually to determine water quality, and monthly to determine water levels. During this reporting period water levels in the upper aquifer were generally stable or rising. Rising water levels were reported in the southern portion of the tract, while the central portion was stable to declining, and the northern portion was rising to stable.

The lower aquifer water levels showed a general decline throughout the area of 1 to 2 feet, with a few areas seemingly stable.

Deep oil shale aquifer samples were last collected during March of 1976. All of the analayses from these samples were not finished for inclusion in Progress Report 7. Those analyses that have been received that were not included in Progress Report 7 have been included in this Progress Report.

ABSTRACT

This report presents the progress of RBOSP's environmental baseline studies during the eighth quarter of study (June, July and August 1976). Studies reported include air quality, meteorology, terrestrial and aquatic ecology, soils, archaeology and trace metals.

Analysis of air quality parameters measured on Tract C-a indicates that, with the exception of ozone and hydrocarbons, the mean values are in the expected low background ranges. The seasonal mean values for CO, H_2S and SO_2 are comparable to the lower limits of detectability of the analyzers.

The particulate concentrations observed during this quarter did not violate the federal 24-hour maximum primary or the state 24-hour maximum standard. The federal secondary standard was exceeded three times during the reporting quarter.

Wind speeds at Sites 1 and 2 were slightly higher than at Sites 3 and 4, with a maximum wind speed of 9.35 mph recorded at Site 2. Prevailing wind direction at Site 1 was from the west southwest and from the southwest at Site 2.

The valley sites (3 and 4) had a much larger diurnal temperature variation than the plateau sites (1 and 2). The intensity of the cold portion of the composite days at Sites 3 and 4, in relation to that at Sites 1 and 2, is much greater. This probably results from valley drainage of cold air.

Atmospheric stability studies indicated mean surface inversions exist during the interval from 2000 hours MST to 0700 hours MST the following morning. The intensity of the inversion was relatively weak; however, when breakup occurred, delta temperature values became significantly unstable.

Upper air studies were not conducted during this period.

Ten different vegetation types were sampled in the study area during June. The flora identified to date includes 5 tree species, 37 shrub species, 162 forb species and 47 grass or grass-like species. Three new species were added to this list. The grazing exclosure was sampled during this quarter. Sagebrush was the dominant shrub species in three of the four compartments, while pinyon pine and juniper were the dominant canopy species.

Small mammal live trapping efforts yielded 2,023 individuals representing 11 species. Trapping success for the eighth quarter was 37%, with the deer mouse and least chipmunk being the most frequently trapped small mammal. The number of captures per 100 trap nights for these two species increased 300% from previous warm weather periods (October 1974 and May, July and September 1975). Removal trapping yielded 12 species plus five shrews currently being identified by a taxonomist. No new small mammal species were recorded during the quarter.

Only five mule deer were observed during this quarter, and they were located in the Cathedral Bluff area. A maximum of 98 feral horses were observed during the June survey, with a total of 137 observed during the eighth quarter. Herds varied in size from 4 to 12. Only one elk was observed during the quarter; it was located west of Tract C-a. Pellet counts were also conducted during this period. The maximum pellet count index was .9 on Transects 5 and 6, located east of Tract C-a.

Mammalian predator surveys were also conducted during this reporting period. Indices associated with the scent stations varied from 10.3 to 29.3 for Lines A and B. Station response indices for the siren program varied from 55 to 95. No predators were captured in the Havahart traps, although three weasels were captured in the Sherman traps.

One new bird species was encountered this quarter, bringing the total number of species in the area to 139. Fifty-three species were observed during the summer quarter. Transect 11 (sagebrush) exhibited the lowest species diversity index. Riparian habitat exhibited the highest density index with the lowest density associated in an upland meadow community. A sage grouse brood survey was conducted during the summer, with a total of one adult bird observed. Blue grouse booming grounds were visited, with seven adult males, four adult females and four juveniles being recorded. Waterfowl were observed in the Stake Springs impoundments.

Aerial raptor surveys produced 18 individuals representing seven raptor species. A ground raptor nest search was also conducted which located an active golden eagle's eyrie.

Four reptile species were encountered during the summer field program. Two species of amphibians were reported during the amphibian breeding survey.

Extensive invertebrate sampling and laboratory analysis was conducted during this period. Numerically, the predominate groups changed with each of the sampling methods.

Five hundred forty-three domestic livestock were counted during aerial surveys.

During the aquatic sampling period, nine stations were dry or inaccessible for sampling due to high water in the White River. A total of 118 alga taxa were observed in April and 122 observed in May-June. Zooplankton taxa totals were 73 for May-June 1976. A total of 99 periphytic algal taxa were reported. Macroinvertebrates were only partially analyzed; however, five species of macrophytes were identified. Fish sampling accounted for 171 fish representing six species.

Stream velocities varied from no flow at Stations 5, 17 and 18 to 5-8 feet per second at Station 23 (May-June).

Soil studies conducted during this quarter included chemical analysis of samples. This data will then be transferred to standard 80-column punch cards.

The cultural resource document has been reviewed and currently suggestions are being incorporated. This document includes archaeology, paleontology and historic landmarks.

Visibility studies were conducted during this period. During summer, sector visibility ranged from 2 to 150 miles. The 2-mile sector visibility occurred on 11 August 1976.

Noise measurements were collected in the study area. In general, the results of the two studies agreed: wind played an important factor in decibel readings for both studies.

Field studies estimating seedling emergence and survival on the 1975 revegetation plots have been completed. Data from these studies are being analyzed and the results will be reported by the end of the current year.

2.0 ENVIRONMENTAL BASELINE DATA GATHERING PROJECT

Multidisciplinary environmental baseline data gathering programs have been on-going for the RBOSP since October 1974. Areas of study include air quality, meteorology, terrestrial ecology, aquatic ecology, archaeology, soils, revegetation, paleontology, trace metals and seismicity. Some parameters are monitored continuously (e.g., air quality); other parameters are monitored seasonally (e.g., small mammal studies). Still other parameters are determined at regular intervals (e.g., visibility) or once or twice during the life of the project (e.g., seismicity).

Reports covering progress in each of these areas are submitted to the Area Oil Shale Supervisor on a quarterly basis. The quarter reported herein covers the period from June through August 1976. This represents the eighth quarter of study.

In most cases, objectives and methods for each of the parameters studied have been thoroughly discussed in one of the previous seven progress reports. These discussions have been omitted from this report, but the numbering system for sections has been retained to facilitate comparison with previous reports. In some cases, no data were collected in a particular area during the quarter. No reference is made to these studies in the text; however, they are identified in the Table of Contents as "no data collected".

Revegetation studies during the quarter were limited to the laboratory rearing of six grass species to provide voucher specimens at various ages for taxonomic purposes and continuing review of the literature. Toxicological studies are being conducted by RBOSP personnel, but are not within the scope of the environmental baseline studies and are not reported herein. Section 2.5.6, Visibility, has been deleted so that all visibility studies can be discussed in Section 2.2.3.

.1 AIR QUALITY

Air quality data are collected at four locations in the vicinity of Tract C-a. Parameters measured and locations of stations have been described in previous progress reports. Data reported herein cover the Summer 1976 quarter (June 1, 1976 through August 31, 1976).

.1.1 Parameters

Analysis of the air quality parameters measured on Tract C-a indicates that with the exception of ozone and hydrocarbons, the mean values are in the expected low background ranges. Results of the analysis are discussed and tabulated in this section.

Table 2.1-1 presents a comparison of federal and state standards with measurements taken from 1 June 1976 through 31 August 1976 at the RBOSP sites. None of the gaseous variables exceeded standards during the quarter. The measurement instrument specifications are illustrated in Table 2.1-2.

The particulate concentrations observed during this quarter did not violate either the federal 24-hour maximum primary or the state 24-hour maximum standards. The federal secondary 24-hour standard was exceeded three times during the quarter. All exceedences occurred at Site 4. Also, the mean value for all sites for the quarter, if continued at the same rate, would not result in an annual mean higher than the federal or state annual particulates standard.

Seasonal minimum, maximum, and mean values for all air quality parameters for Summer 1976 are presented in Table 2.1-3.

The seasonal mean values for CO, H_2S, and SO_2 shown in Table 2.1-3 are similar in value to the lower limit of detectability of the analyzers. Mean seasonal values of ozone are similar in magnitude to the maximum levels specified by the regulatory standards. The levels of these compounds appear to be background and not associated with man's activity. The hydrocarbon (both methane and total hydrocarbon) concentrations remain relatively constant throughout the day, while the ozone exhibits definite diurnal variations with a maximum at about noon and a minimum at about midnight.

Table 2.1-4 gives the particulate concentration for the quarter for each site. The frequency of sampling at Sites 1 and 3 was increased during the Spring quarter to further define particulate concentrations. The large variation between samples and sites is expected. Considerable fugitive dust is more than likely due to activities on the tract. For example, Site 3 is not far from a well-traveled road

Table 2.1-1. Comparison of Federal and State air quality standards to measurements made during Summer 1976, RBOSP.

Parameter	Standard		Time Interval	Type of Standard	No. of Times Exceeded During Quarter	Site 1 Max. Measured Value			Site 2 Max. Measured Value			Site 3 Max. Measured Value			Site 4 Max. Measured Value		
	$\mu g/m^3$	(ppm)				$\mu g/m^3$	ppm	Time	$\mu g/m^3$	ppm	Time	$\mu g/m^3$	ppm	Time	$\mu g/m^3$	ppm	Time
CO	40,000	(35)	1 hr max.	Primary & Secondary[1/]	0	1384	1.209	1600 6/2	—	—	—	1491	1.302	0900 6/17	—	—	—
CO	10,000	(9)	8 hr max.	Primary & Secondary[1/]	0	877	0.766	1700 8/14	—	—	—	1401	1.224	1300 6/17	—	—	—
Nonmethane Hydrocarbon	160	(0.24)	3 hr max. (6-9 am only)	Primary & Secondary[1/]	0	114	0.174	6/5	147	0.225	8/11	21	0.032	6/20	44	0.068	8/14
NO_2	100	(0.05)	Annual Arith. Mean	Primary & Secondary[1/]	NA	0[3/]	0.000[3/]	NA	—	—	—	0[3/]	0.000[3/]	NA	—	—	—
Ozone	160	(0.08)	1 hr max.	Primary & Secondary[1/]	0	110	0.056	0100 6/17	—	—	—	133	0.068	1400 7/3	—	—	—
SO_2	365	(0.14)	24 hr max	Primary[1/]	0	18	0.007	0000 6/23	1	0.0003	1800 8/9	21	0.008	1300 6/5	55	0.021	1800 8/24
SO_2	80	(0.03)	Annual Arith. Mean	Primary[1/]	NA	3[3/]	0.001[3/]	NA	0[3/]	0.000[3/]	NA	10[3/]	0.004[3/]	NA	8[3/]	0.003[3/]	NA
SO_2	1300	(0.5)	3 hr max.	Secondary[1/]	0	94	0.036	0000 7/1	3	0.001	1700 7/1	58	0.022	1900 7/16	112	0.043	1700 8/24
Particulates	260		24 hr max.	Primary[1/]	0	81	NA	7/21	57	NA	8/26	105	NA	8/22	173	NA	6/3
Particulates	75		Annual Geo. Mean	Primary[1/]	NA	22[4/]	NA	NA	22[4/]	NA	NA	27[4/]	NA	NA	32[4/]	NA	NA
Particulates	150		24 hr max.	Secondary[1/]	3	81	NA	7/21	57	NA	8/26	105	NA	8/22	173	NA	6/3
Particulates	60		Annual Geo. Mean	Secondary[1/]	NA	22[4/]	NA	NA	22[4/]	NA	NA	27[4/]	NA	NA	32[4/]	NA	NA
Particulates	150[6/]		24 hr max.	State[2/]	0	62	NA	7/21	44	NA	8/26	80	NA	8/22	132	NA	6/3
Particulates	45[6/]		Annual Arith. Mean	State[2/]	NA	21[3/]	NA	NA	19[3/]	NA	NA	25[3/]	NA	NA	35[3/]	NA	NA

1/ Environmental Protection Agency Regulations on national primary and secondary ambient air quality standards (40 CFR 50: 36 FR 22384, November 25, 1971: as amended by 38 FR 25678, September 14, 1973; 40 FR 7042, February 18, 1975).

2/ Ambient air standards for metropolitan Denver air quality control region, air quality contral areas, and the State of Colorado; Adopted: September 10, 1970, Effective: December 17, 1970, amended September 4, 1974, amended September 4, 1975.

3/ Arithmetic mean of values measured during the quarter.

4/ Geometric mean of values measured during the quarter.

5/ All EPA Standards are at reference conditions of 25°C and 760 mmHg.

Table 2.1-2. Air quality instrumentation and measurement techniques, RBOSP.

Parameter	Manufacturer	Model	Technique	Lower Detectable Limit (ppm) 1/	Accuracy ± (ppm)
SO_2/H_2S	Bendix	8700X	Flame photometric with separation column for SO_2 and H_2S	0.005	0.020
NO_x/NO	Bendix	8101-B	Chemiluminescence	0.005	0.010
THC/CH_4	Bendix	8201	Flame ionization detector with separation column for CH_4	0.005	0.10 (THC) 0.02 (CH_4)
Photochemical Oxidant (O_3)2/	Bendix	8002	Chemiluminescence	0.001	0.004 3/
CO	Bendix	8501-5CA	Nondispersive infrared detector	0.5	0.500 3/

1/ LDL is the lowest concentration that can be differentiated from instrument noise.

2/ Photochemical oxidant corrected for interference due to nitrogen oxide and nitrogen dioxide as measured by the Federal Reference as ozone (O_3) with the chemiluminescence method.

3/ Estimated accuracy.

Table 2.1-3. Air quality parameters, seasonal summary for Summer 1976, RBOSP.[1]

Parameter	Units	Minimum	Maximum	Arithmetic Mean
		SITE 1		
O_3	ppm	0.017	0.056	0.035
CO	ppm	0.000	1.209	0.295
NO	ppm	0.000	0.237	0.028
NO_x	ppm	0.000	0.234	0.027
CH_4	ppm	1.057	1.485	1.351
THC	ppm	1.106	1.523	1.375
H_2S	ppm	0.000	0.047	0.002
SO_2	ppm	0.000	0.092	0.001
Particulates	$\mu g/m^3$	4	81	22[2]
		SITE 2		
CH_4	ppm	1.227	1.514	1.393
THC	ppm	1.178	1.630	1.424
H_2S	ppm	0.001	0.004	0.002
SO_2	ppm	0.000	0.004	0.000
Particulates	$\mu g/m^3$	10	57	22[2]
		SITE 3		
O_3	ppm	0.005	0.068	0.036
CO	ppm	0.000	1.302	0.424
NO	ppm	0.000	0.012	0.003
NO_x	ppm	0.000	0.016	0.003
CH_4	ppm	0.879	1.608	1.423
THC	ppm	0.842	1.667	1.434
H_2S	ppm	0.001	0.034	0.003
SO_2	ppm	0.002	0.049	0.004
Particulates	$\mu g/m^3$	5	105	27[2]
		SITE 4		
CH_4	ppm	1.111	1.546	1.413
THC	ppm	1.274	1.699	1.441
H_2S	ppm	0.001	0.045	0.003
SO_2	ppm	0.000	0.046	0.003
Particulates	g/m^3	11	173	32[2]

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[1] Values presented are based upon hourly averages

[2] Geometric mean

Table 2.1- 4. Particulate concentration data for Summer 1976; values are presented in μg/m^3, RBOSP.

Month	Day	Year	Site 1	Site 2	Site 3	Site 4
June	1	1976	17[1/]		19[1/]	
	3		23	25	32	173
	5		49		44	
	6			35		122
	7		19[1/]		22[1/]	
	9		33	28	36	160
	11		61		59	
	12			10		40
	13		7[1/]		11[1/]	
	15		6	10	7	15
	17		7		5	
	18			11		14
	19		4[1/]		5[1/]	
	21		20	22	28	164
	23		15		16	
	24			20		21
	25		23[1/]		17[1/]	
	27		21	26	30	32
	29		34		37	
	30			41		87
July	1		17[1/]		24[1/]	
	3		67	30	27	53
	5		24		43	
	6			38		47
	7		19[1/]		35[1/]	
	9		35	37	81	48
	11		33		46	
	12			48		33
	13		11[1/]		26[1/]	
	15		50	25	93	19
	17		42		75	
	18			17		13
	19		5[5/]		12[1/]	
	21		81	15	27	14
	23		38		70	
	24			26		33
	25		17[1/]		35[1/]	
	27		26	21	29	17
	29		31		47	
	30			27		27
	31		19[1/]		20[1/]	

Table 2.1-4. Particulate concentration data for Summer 1976; values are presented in $\mu g/m^3$, RBOSP. (Cont.)

Month	Day	Year	Site 1	Site 2	Site 3	Site 4
August	2	1976	54	10	15	11
	4		24		29	
	5			16		28
	6		17[1]		21[1]	
	8		33	52	33	31
	10		31		28	
	11			21		22
	12		7[1]		7[1]	
	14		23	21	29	30
	16		23		36	
	17			14		22
	18		7[1]		18[1]	
	20		21	19	27	22
	22		30		105	
	23			14		13
	24		15[1]		26[1]	
	26		39	57	41	58
	28		15		27	
	29			17		15
	30		35[1]		31[1]	

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[1] Total particulate concentration from the particulate sizing measurement.

Particle size data by concentration and particle size range are given in Table 2.1-5. These data show that a large portion of the particulate weight is made up of particles of 0 to 0.95 μm. The values indicated by <1 $\mu g/m^3$ are less than the estimated concentration measurable by the data collection technique.

The results of particle trace element analysis on a particulate sample taken over one 24-hour period during the quarter are given in Table 2.1-6.

Table 2.1-5. Particulate concentration by equivalent aerodynamic diameter[1] at Site 1 for Summer 1976, RBOSP.

Size Range (microns)	6/1	6/7	6/13	6/19	6/25	7/1	7/7	7/13	7/19	7/25	7/31	8/6	8/12	8/18	8/24	8/30
7.2 - ∞	1	1	<1	<1	1	1	<1	1	<1	1	2	<1	1	<1	1	3
3.0 - 7.2	2	1	<1	<1	1	2	1	1	1	2	2	<1	1	1	2	3
1.5 - 3.0	1	1	<1	<1	1	1	<1	1	<1	<1	1	<1	<1	1	1	2
0.95 - 1.5	1	<1	<1	<1	1	1	1	<1	<1	1	1	<1	<1	<1	<1	2
0.0 - 0.95	12	16	7	4	19	12	17	8[2]	4	13	13	17	5	5	11	25

1/ "Equivalent Aerodynamic Diameter" is defined as the size of a spherical particle of density 1 gm/cc, which has the same terminal settling velocity as the sampled particle.

2/ Corner missing on filter, approximate weight only.

Table 2.1-6. High volume filter, analytical trace element results for Summer 1976, RBOSP.[1/]

Parameter	Concentration (ng/m^3)	Parameter	Concentration (ng/m^3)	Parameter	Concentration (ng/m^3)	Parameter	Concentration (ng/m3)
Uranium	<0.05	Terbium	<0.03	Ruthenium	<0.03	Vanadium	2.0
Thorium	<0.06	Gadolinium	<0.03	Molybdenum	0.24	Titanium	130
Bismuth	0.08	Europium	<0.03	Niobium	0.36	Scandium	<0.03
Lead	8.7	Samarium	<0.13	Zirconium	0.47	Calcium	620
Thallium	<0.05	Neodymium	1.0	Yttrium	0.64	Potassium	550
Mercury	<0.027	Praseodymium	0.21	Strontium	4.6	Chlorine	5.0
Gold	<0.03	Cerium	0.87	Rubidium	1.7	Sulphur	20
Platinum	<0.03	Lanthanium	0.78	Bromine	1.8	Phosphorus	49
Iridium	<0.03	Barium	13	Selenium	0.10	Silicon	870
Osmium	<0.03	Cesium	0.34	Arsenic	1.3	Aluminum	≃2100
Rhenium	Internal Standard						
		Iodine	0.08	Germanium	<0.03	Magnesium	81
Tungsten	0.09	Tellurium	<0.03	Gallium	0.14	Sodium	36
Tantalum	0.12	Antimony	0.04	Zinc	5.0	Fluorine	19
Hafnium	<0.17	Tin	0.76	Copper	16	Oxygen	NR
		Indium	Internal Standard				
Lutecium	<0.03			Nickel	4.0	Nitrogen	NR
Ytterbium	<0.13	Cadmium	0.06	Cobalt	0.48	Carbon	NR
Thullium	<0.03	Silver	0.11	Iron	250	Boron	NR
Erbium	<0.03	Palladium	<0.03	Manganese	6.6	Beryllium	<0.03
Holmium	<0.03	Rhodium	<0.03	Chromium	0.82	Lithium	0.16
Dysprosium	<0.04						

[1/] Samples are collected on cellulose filters and analyzed by spark source mass spectrometry.

NR - Not Reported

2 METEOROLOGY

Meteorological parameters measured and locations of sites are given in previous progress reports. Upper air studies are scheduled to be done for 5 quarters of the baseline program. An upper air study was not executed during the 8th quarter. Tracer diffusion studies are scheduled to be conducted later this year. Ambient noise level measurements have been completed for the first baseline monitoring year.

The baseline meteorological program is established at two lower atmospheric levels, referred to in this report as lower air studies and upper air studies. The lower air studies include data obtained from the four station network; the upper air studies involve obtaining data on the winds aloft and vertical temperature profiles. Upper air studies are performed on a seasonal basis. Upper air measurements are performed during the baseline study period concurrently with tracer studies. Studies which provide useful information, but do not fall into these categories are: precipitation, evaporation, solar radiation, noise, snowcourse, and visibility (discussed under Miscellaneous, Section 2.2.3).

The Summer 1976 quarter (season), as used in this section, is defined as June 1, 1976 through August 31, 1976.

2.1 Lower Air Studies

The 1976 Summer season summaries of the minimum, maximum, and mean values of the meteorological parameters measured at each site are presented in Table 2.2-1. The composite hour, as illustrated in Figures 2.2-1 through 2.2-6, is the mean of the data taken during a particular hour of the day for all days of the period indicated. A composite day defines the minimum, maximum, and mean values for 24 composite hours of a month. The minimum and maximum listed are the individual hourly averages which are greater than or less than all other hourly averages.

The prevailing 10-m level wind at Site 1 was from the west southwest and the prevailing 10-m level wind at Site 2 was from the southwest during Summer 1976.

The mean wind speeds were 7.90 mph at Site 1 and 9.35 mph at Site 2. Although Sites 1 and 2 are at about the same elevation (7,400 feet above MSL), the local terrain at Site 2 is relatively flatter than at Site 1. The Site 2 monitoring location is the highest point within a radius of approximately 1 km. The 10-m level of the main meteorological tower at Site 1 is approximately 50 m lower than the elevation of several knolls within several hundred meters. The increased terrain influence at Site 1 is probably responsible for the lower mean wind speed.

Table 2.2- 1. Meteorological parameters, seasonal summary for Summer, 1976, RBOSP.

Parameter	Units	Minimum	Maximum	Mean
		SITE 1		
Wind Speed (10 m)	mph	1.06	28.47	7.90
Wind Speed (30 m)	mph	0.98	36.25	9.26
Wind Speed (60 m)	mph	0.90	40.69	10.85
Wind Direction Sigma (10 m)	degrees	1.05	31.05	12.87
Air Temperature (10 m)	C	-5.30	29.73	18.09
Air Temperature (30 m)	C	-3.78	29.06	18.02
Temperature Difference (10-60 m)	C	-3.01	7.43	0.11
Relative Humidity (10 m)	%	13.10	82.94	22.45
		SITE 2		
Wind Speed (10 m)	mph	0.90	39.20	9.35
Air Temperature (10 m)	C	-4.24	29.40	17.94
		SITE 3		
Wind Speed (10 m)	mph	1.30	25.52	7.46
Air Temperature (10 m)	C	-7.08	32.11	17.23
		SITE 4		
Wind Speed (10 m)	mph	0.93	27.05	6.67
Air Temperature (10 m)	C	-8.00	17.37	17.37

1/ Values presented are based upon hourly averages.

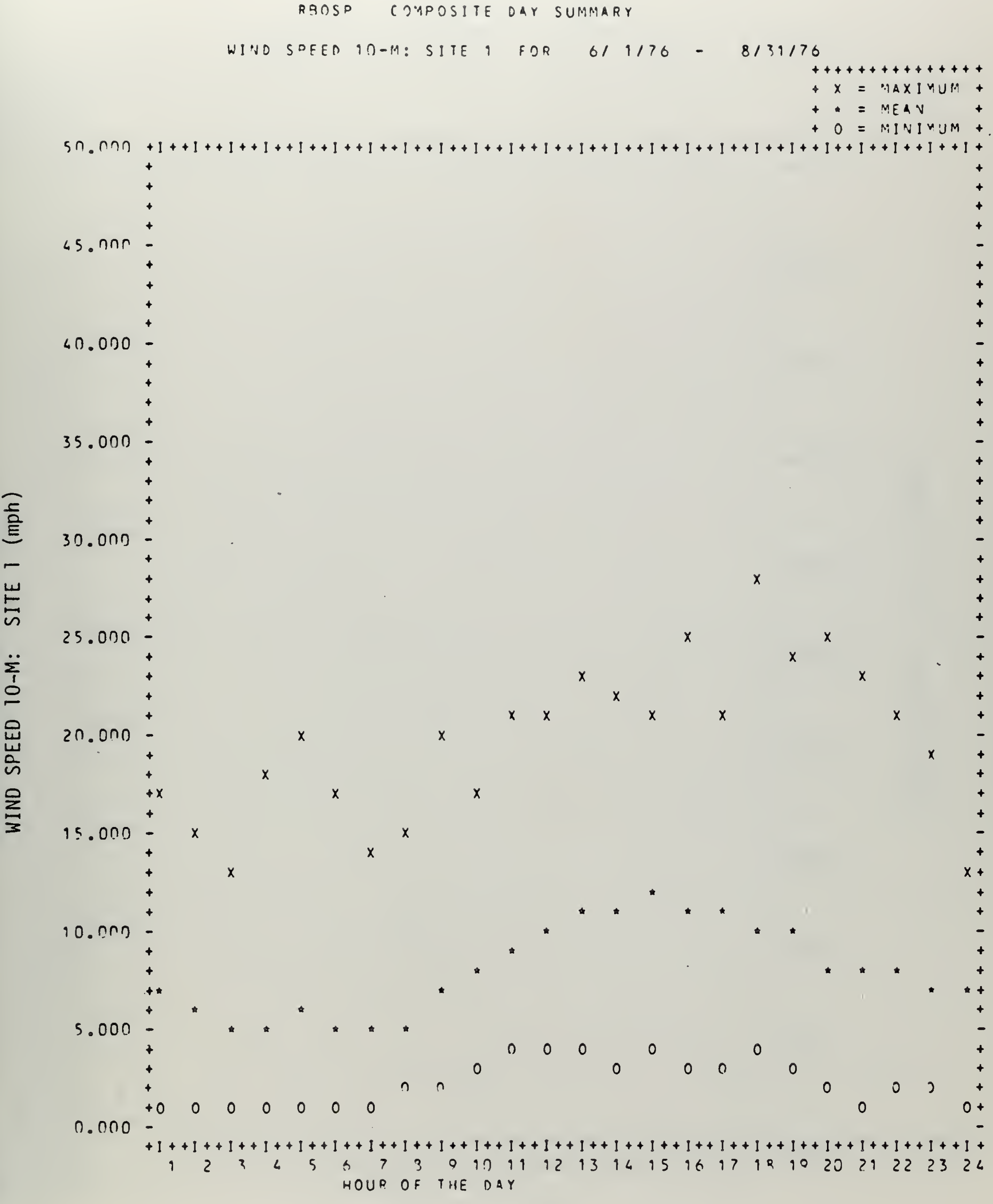

Figure 2.2-1. Wind Speed, 10-m level (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 1, RBOSP.

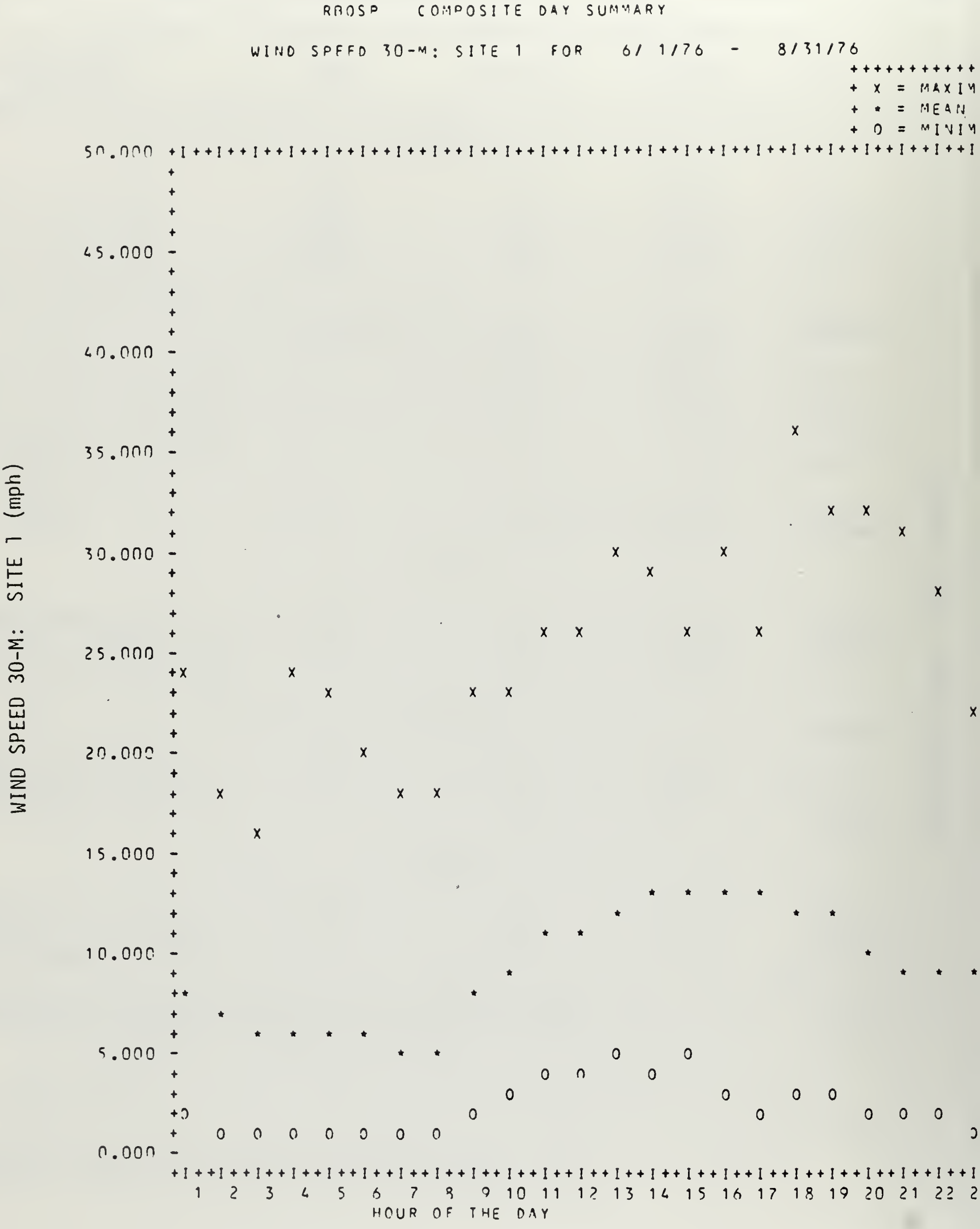

Figure 2.2-2. Wind Speed, 30-m level (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 1, RBOSP.

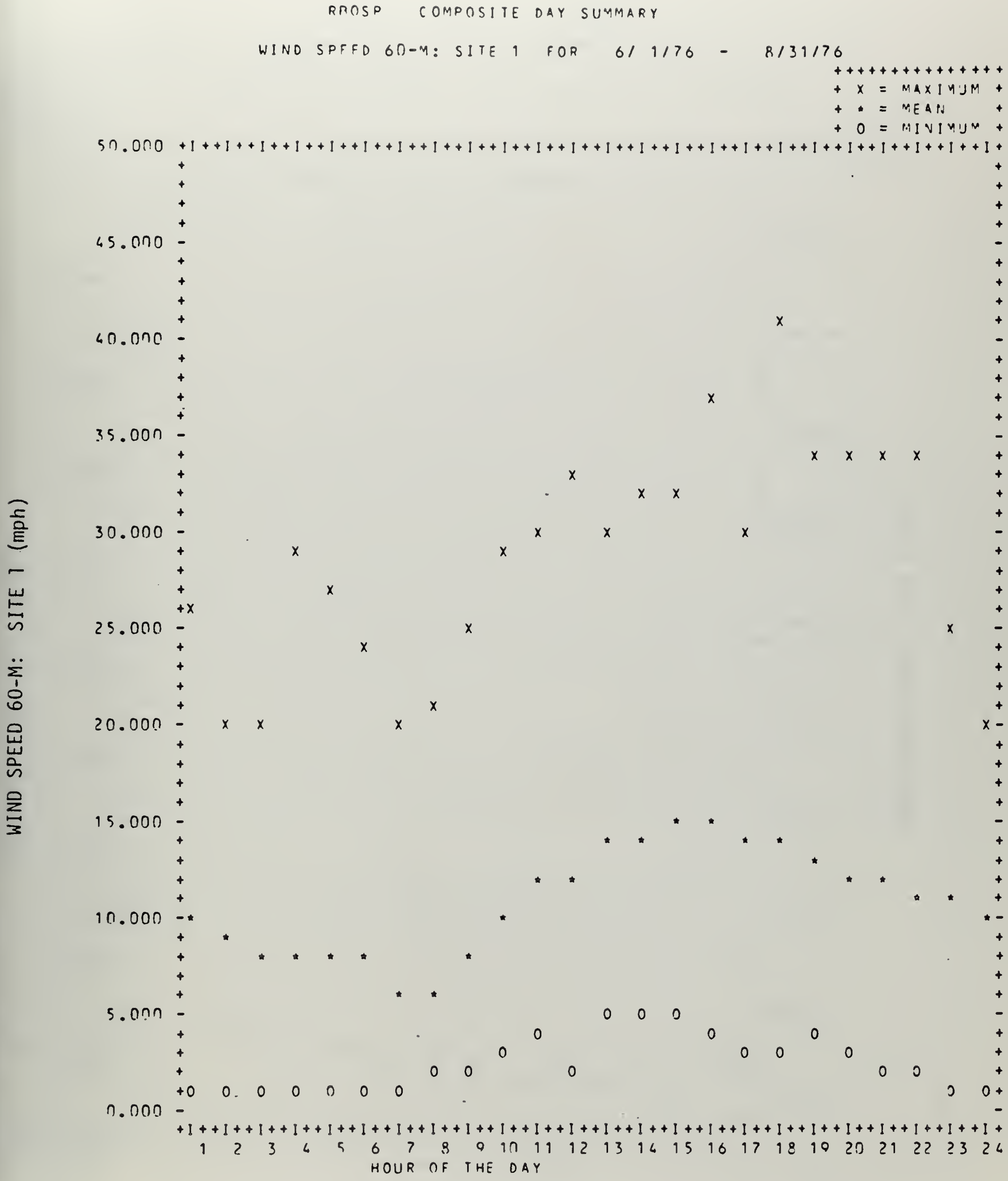

Figure 2.2-3. Wind Speed, 60-m level (minimum, maxiumu, and mean by hour of the day) for Summer 1976 at Site 1, RBOSP.

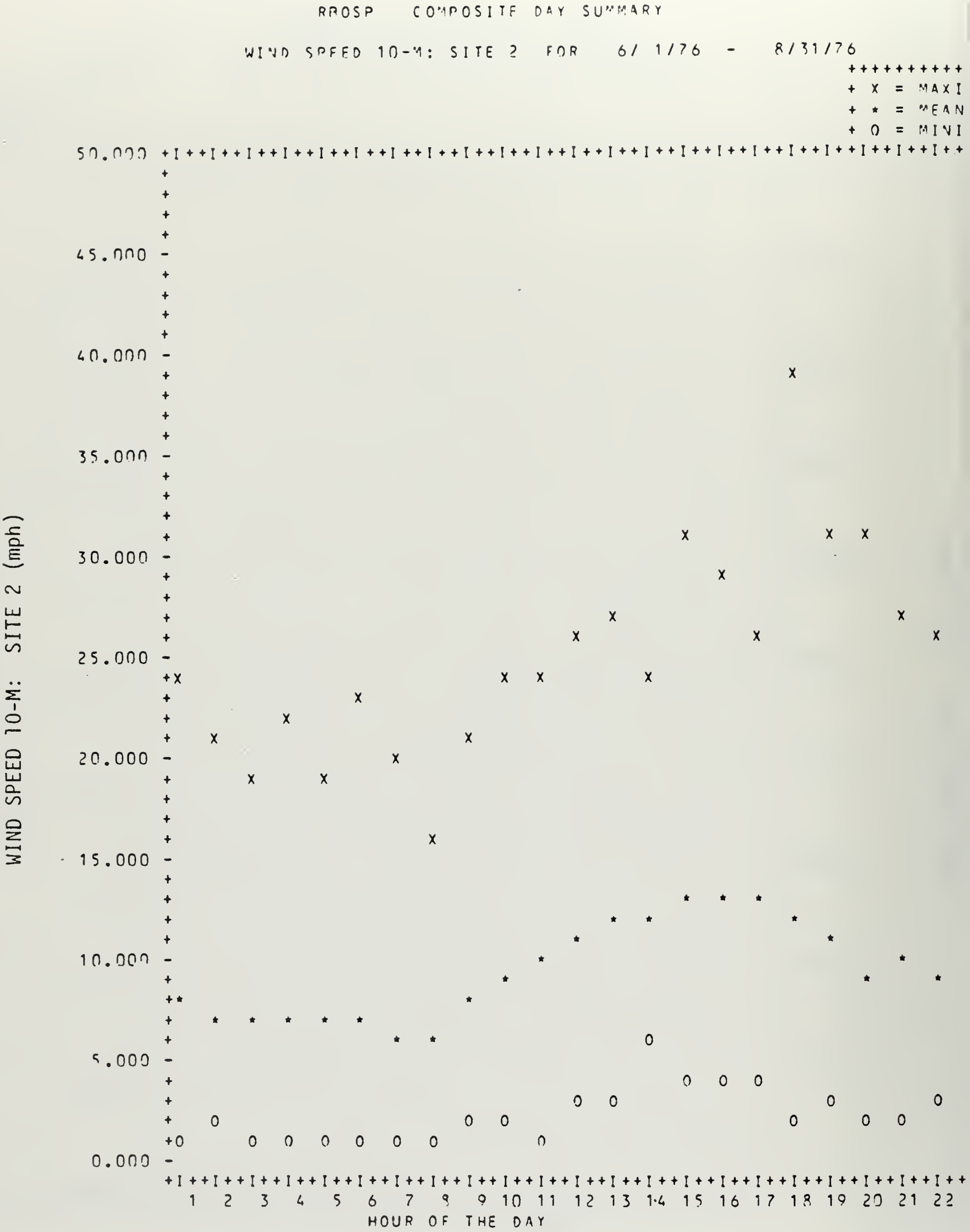

Figure 2.2-4. Wind Speed, 10-m level (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 2, RBOSP.

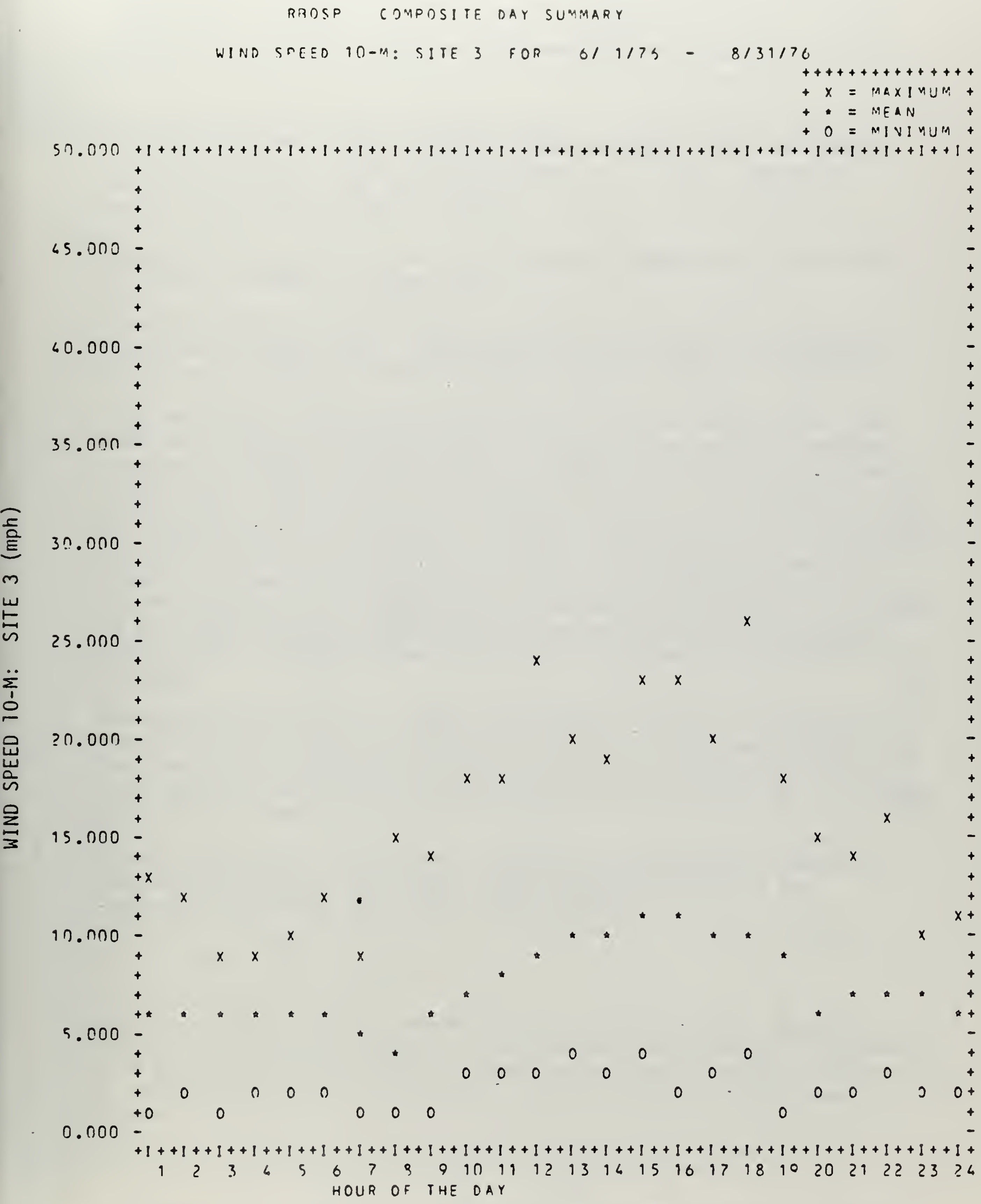

Figure 2.2-5. Wind Speed, 10-m level (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 3, RBOSP.

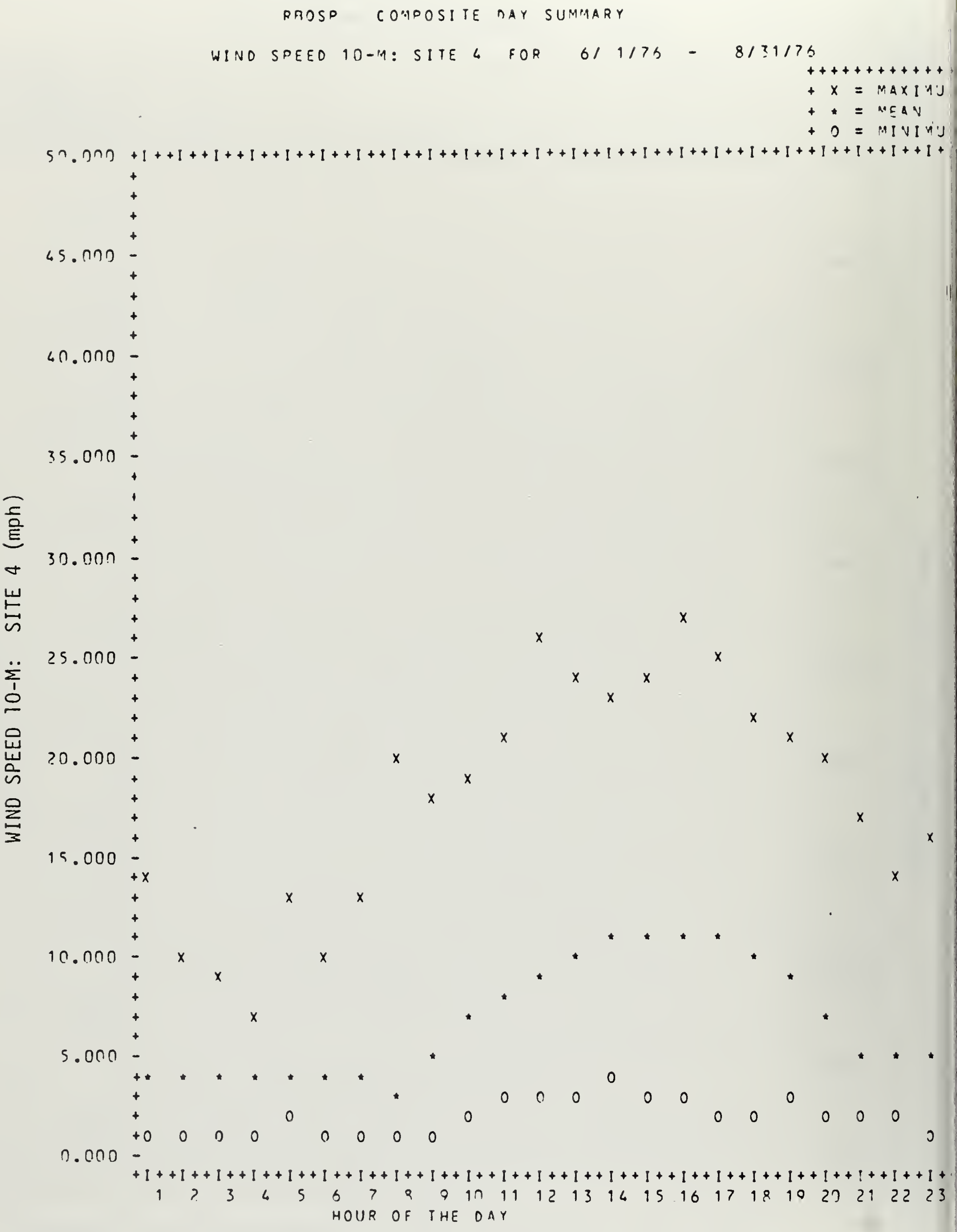

Figure 2.2-6. Wind Speed, 10-m level (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 4, RBOSP.

Mean wind speeds at Sites 3 and 4 for the Summer 1976 period were 7.46 and 6.67 mph, respectively. Sites 3 and 4, below plateau levels, are situated in the approximate centers of Corral Gulch and Yellow Creek Gulch at elevations of 6,570 and 6,280 feet above MSL. Corral Gulch is oriented in a west to east direction. Yellow Creek Gulch is oriented in a south-southwest to north-northwest direction.

The diurnal variation of mean wind speed for each site is shown in Figures 2.2-1 to 2.2-6. Mean wind speeds average 4 to 7 mph higher during daytime hours than nighttime hours with Site 1 showing the smaller variation. The 60-m level has about a 7 mph higher wind speed during the day than at night.

The diurnal variation of the wind direction sigma at the 10-m level at Site 1 is shown in Figure 2.2-7.

Wind rose data for Summer 1976 are presented for all four monitoring stations in Figure 2.2-8. The percent of occurrence of each wind class can be obtained from the number scale on each wind rose plot.

Wind rose data (10-m level) from Sites 1 and 2 are comparable. The reduced frequency of occurrence of southwest winds relative to south-southwest and west-southwest winds is probably caused by the influence from a small knoll about 200 m southwest of Site 1. Extreme terrain-induced wind channeling effects exist at Site 3 and 4. Winds at Site 3 are predominantly from the west and west-southwest, which is in agreement with the westerly course of Corral Gulch. The predominant winds at Site 4 are from the southwest and west-southwest, corresponding closely to the orientation of Stake Springs Draw and Yellow Creek. In addition to the terrain-induced channeling of the gradient winds at Sites 3 and 4, valley drainage flows contribute significantly to the direction of winds.

The term gradient wind is used here to describe wind flows resulting from a pressure difference between two points at the same elevation. The term valley drainage flow is used to describe the winds resulting from radiative cooling of the near surface layers of air which produces a subsiding, down-slope flow.

A least squares fit to the mean seasonal wind speed as a function of height at the 60-m tower (Site 1) was done to investigate the applicability of the logarithmic wind profiles:

$$\bar{u} = \frac{u*}{K} \ln \frac{Z}{Z_o}$$

where Z_o is the roughness parameter, K is the von Karman constant, and u* is the friction velocity. The seasonal data fit the logarithmic wind profile to a high degree of confidence (coefficient of determination, $r^2 = 0.970$) with u*/K = 1.61 mph, $Z_o = 7.9$ cm, and Z = height above ground.

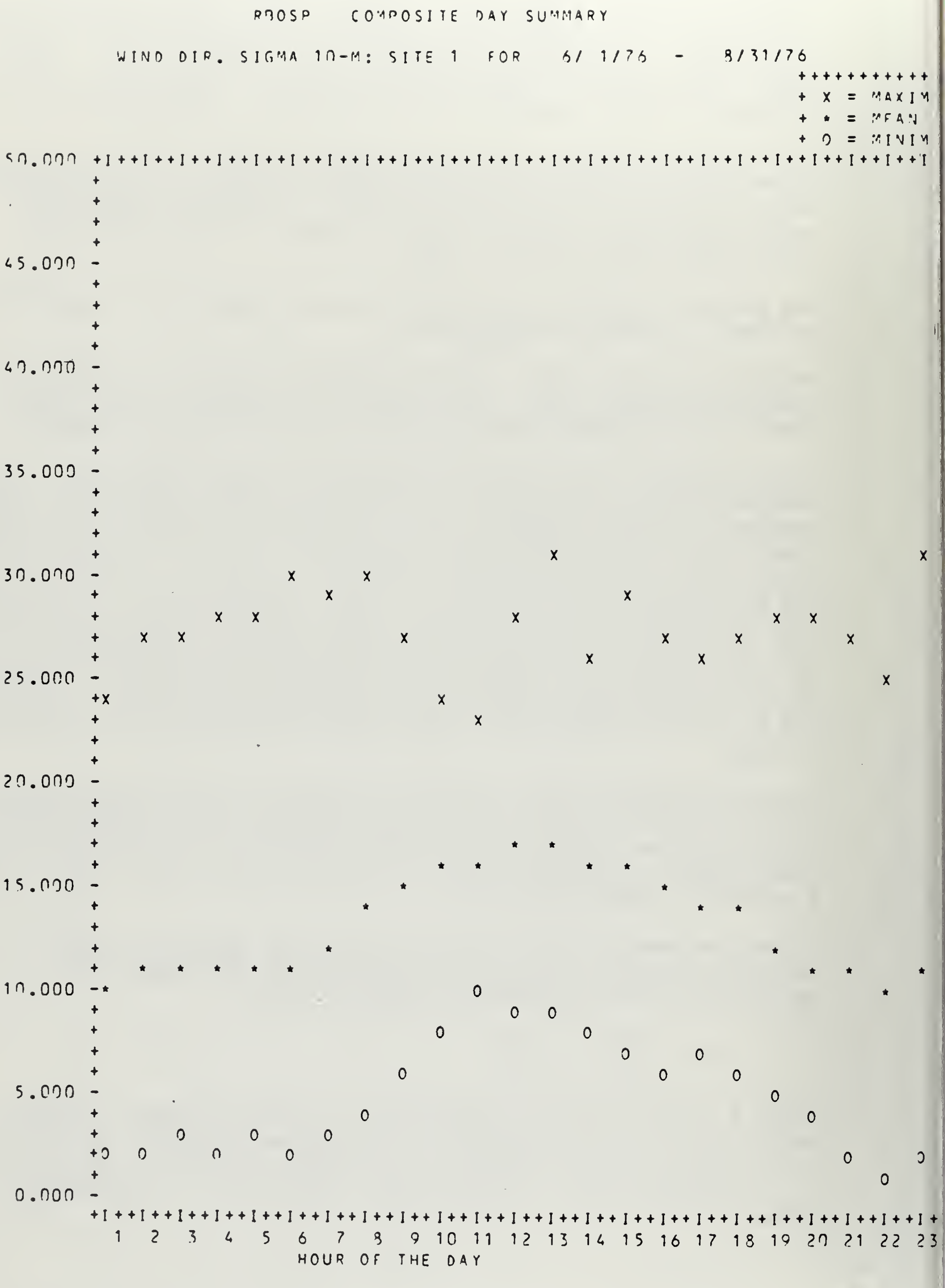

Figure 2.2-7. Wind Direction Sigma, 10-m level (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 1, RBOSP.

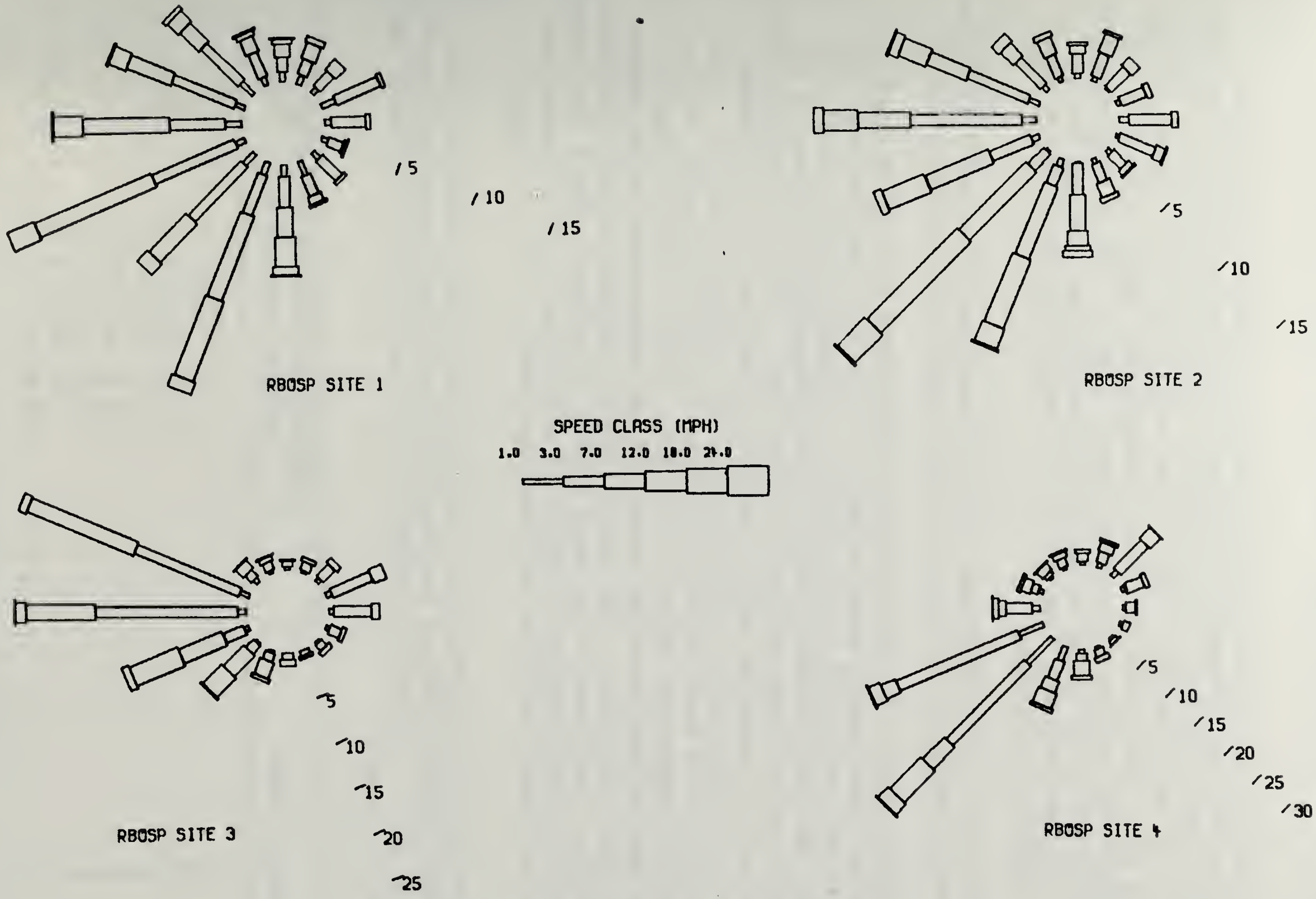

Figure 2.2-8. Wind roses for the 10-m level for Summer 1976 at Sites 1, 2, 3, and 4, RBOSP.

The minimum, maximum, and mean values of air temperature for each of the four sites and temperature difference at Site 1 as a function of the hour of the day for Summer 1976, are plotted in Figures 2.2-9 through 2.2-14.

The valley sites (3 and 4) have a much larger diurnal temperature variation than the plateau sites (1 and 2). The intensity of the cold portion of the composite days at Sites 3 and 4, in relation to that at Site 1 and 2, is much greater. This is the result of valley drainage flows of cold air. The composite day air temperature data for Sites 3 and 4 indicate that colder air accumulates at Site 4. The elevation difference (200 ft) and the Stake Spring Draw air flow, as well as the Corral Gulch air flow draining into the Yellow Creek Gulch, contribute to this intensity difference.

Although there is a difference in the diurnal variation among all sites, the average temperatures over the season agree well between sites.

Atmospheric stability conditions were determined from temperature difference measurements made between the 10-m and the 60-m level on the main meteorological tower at Site 1. Figure 2.2-14 presents the minimum, maximum, and mean composite day temperature differences as a function of the time of day for Summer 1976. The data indicate that a mean surface inversion exists during the interval from 2000 hours MST in the evening until 0700 hours MST the following morning. The intensity of this mean surface inversion is relatively weak, ranging from delta temperature values of -0.04 to -0.69. When the break-up of the mean surface inversion occurs, delta temperature values become significantly unstable. The intensities of the most unstable conditions are greater than those of the most stable inversions. Since the intensities of the most unstable conditions are unusual, delta temperature values for these conditions are being reviewed.

The percentage of occurrence of the modified Pasquill stability categories for Summer 1976 and the associated mean wind speeds are presented in Table 2.2-2. Stability categories were calculated according to the following criteria:

Stability Index	Temperature change (C) with heights per 100 m *
A	$\Delta T < -1.9$
B	$-1.9 \leq \Delta T < -1.7$
C	$-1.7 \leq \Delta T < -1.5$
D	$-1.5 \leq \Delta T < -0.5$
E	$-0.5 \leq \Delta T < 1.5$
F	$1.5 \leq \Delta T < 4.0$
G	$4.0 \leq \Delta T$

* ΔT is equal to minus two times delta temperature.

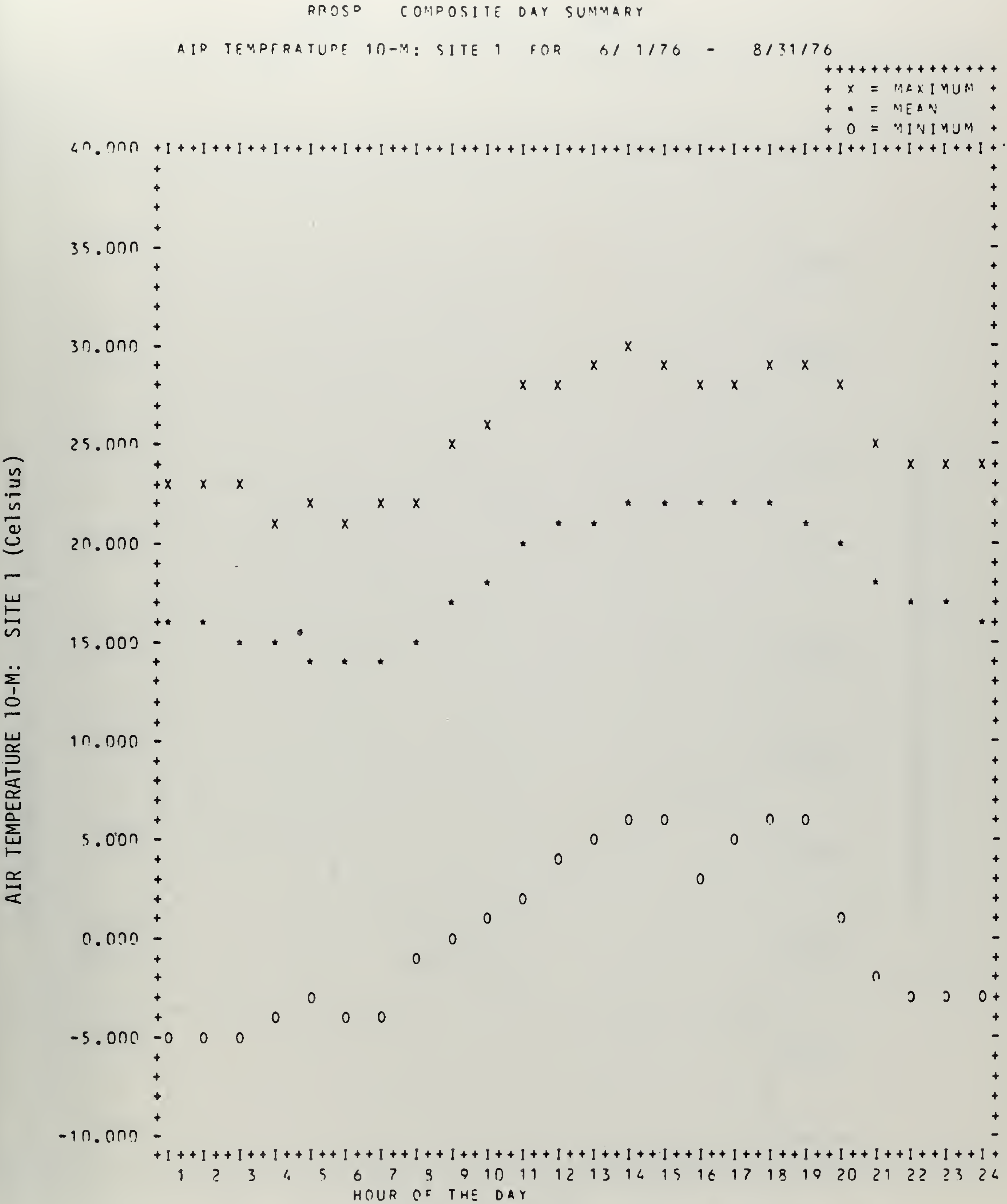

Figure 2.2-9. Air Temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 1, RBOSP.

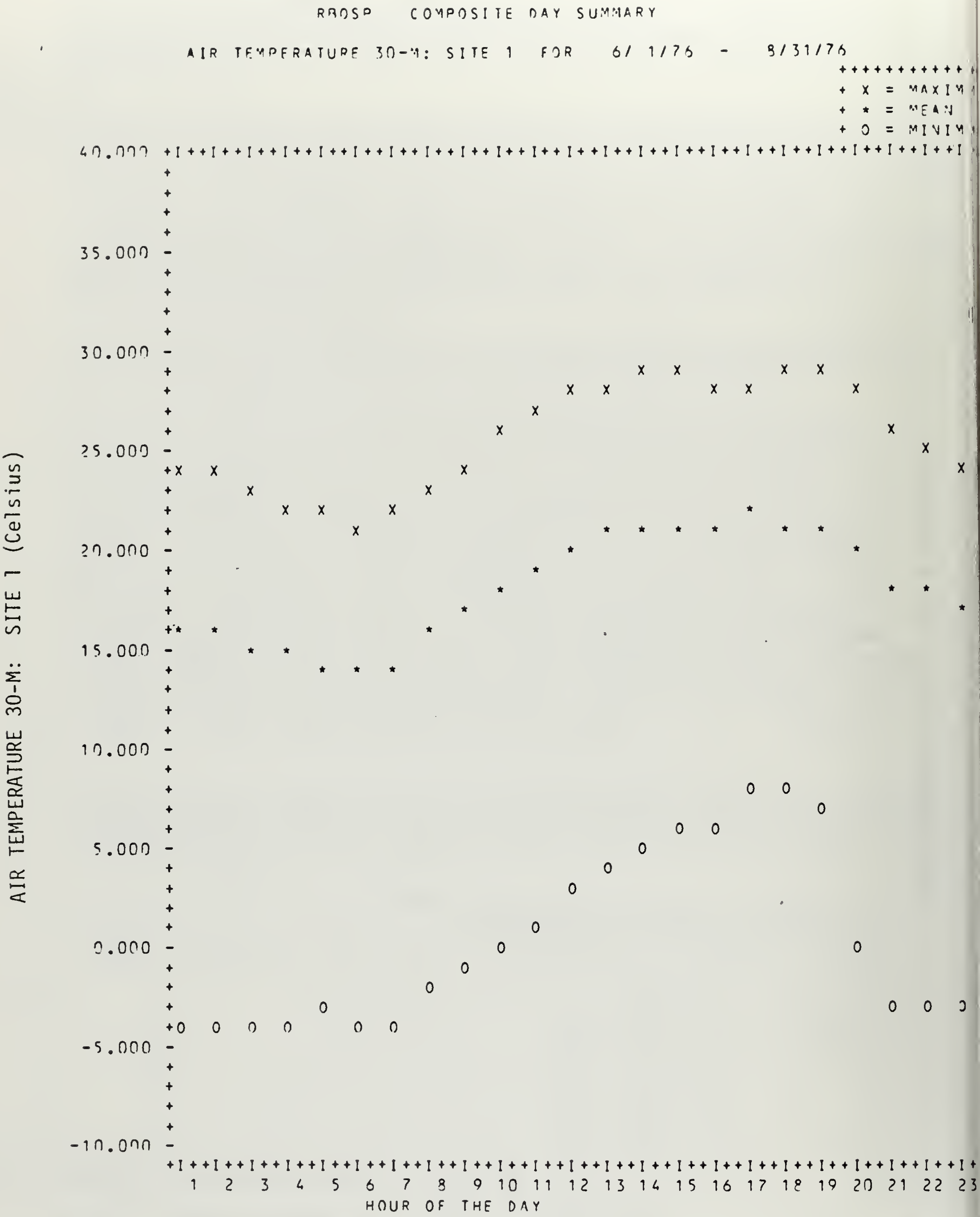

Figure 2.2-10. Air Temperature, 30-m level (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 1, RBOSP.

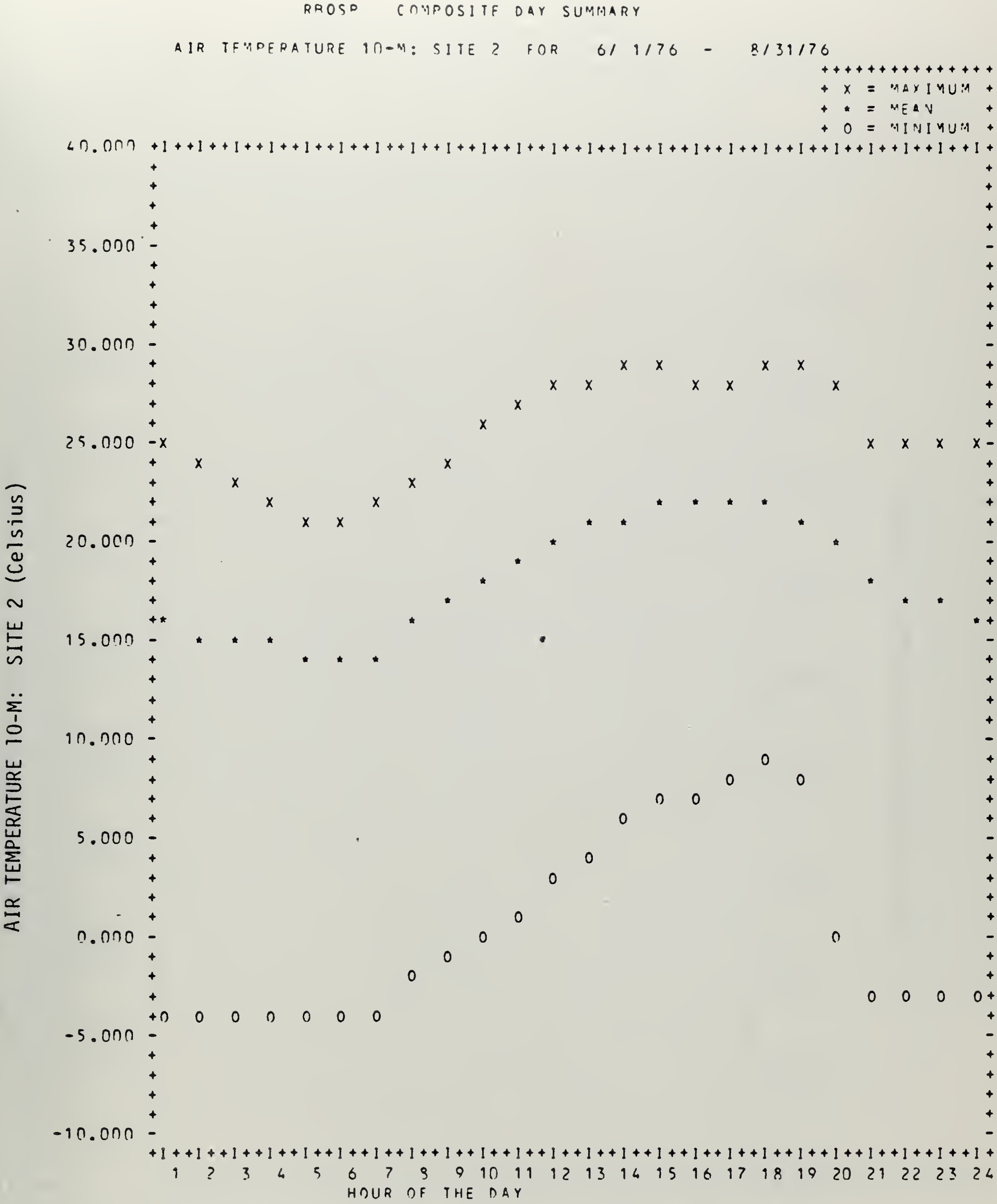

Figure 2.2-11. Air Temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 2, RBOSP.

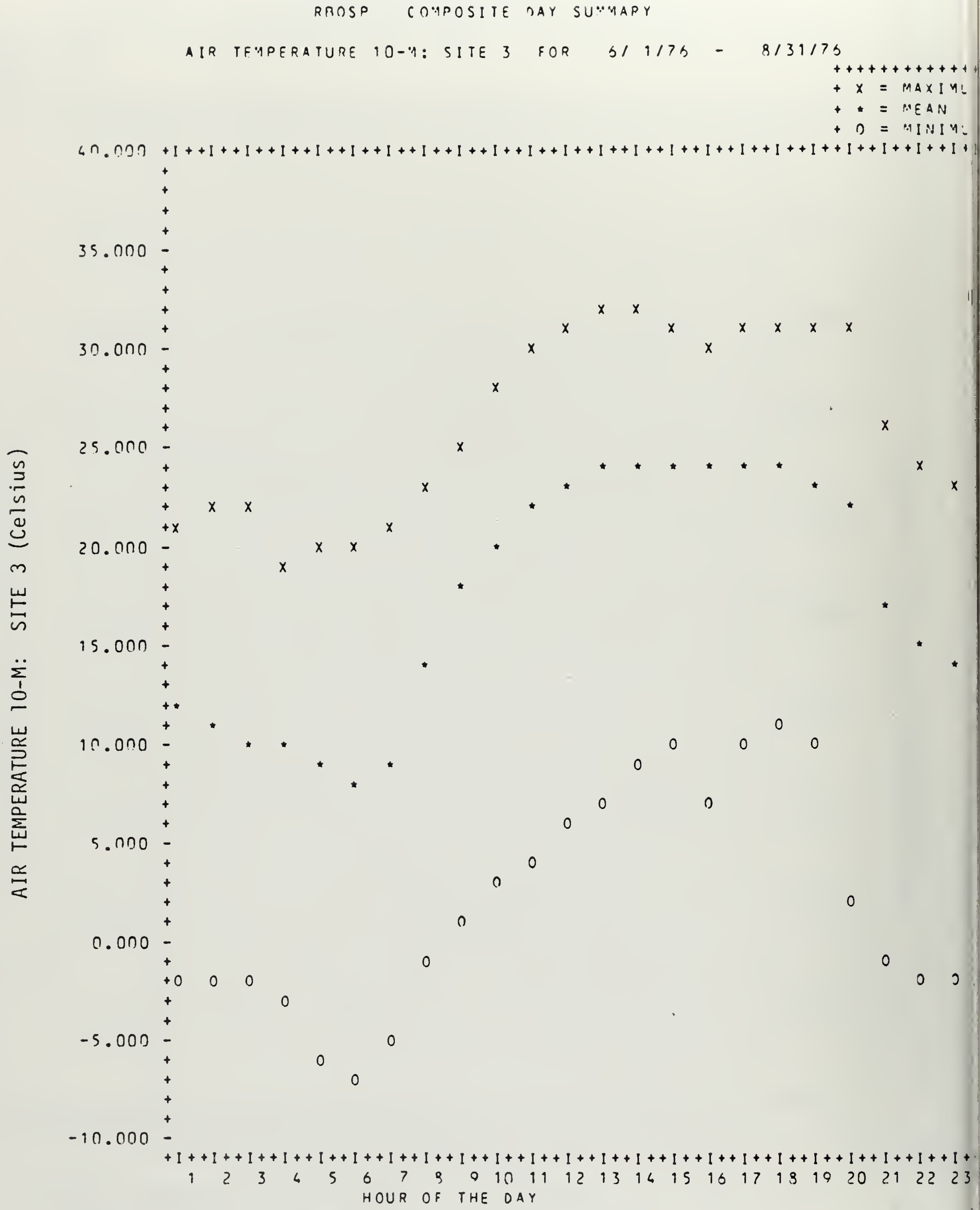

Figure 2.2-12. Air Temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 3, RBOSP.

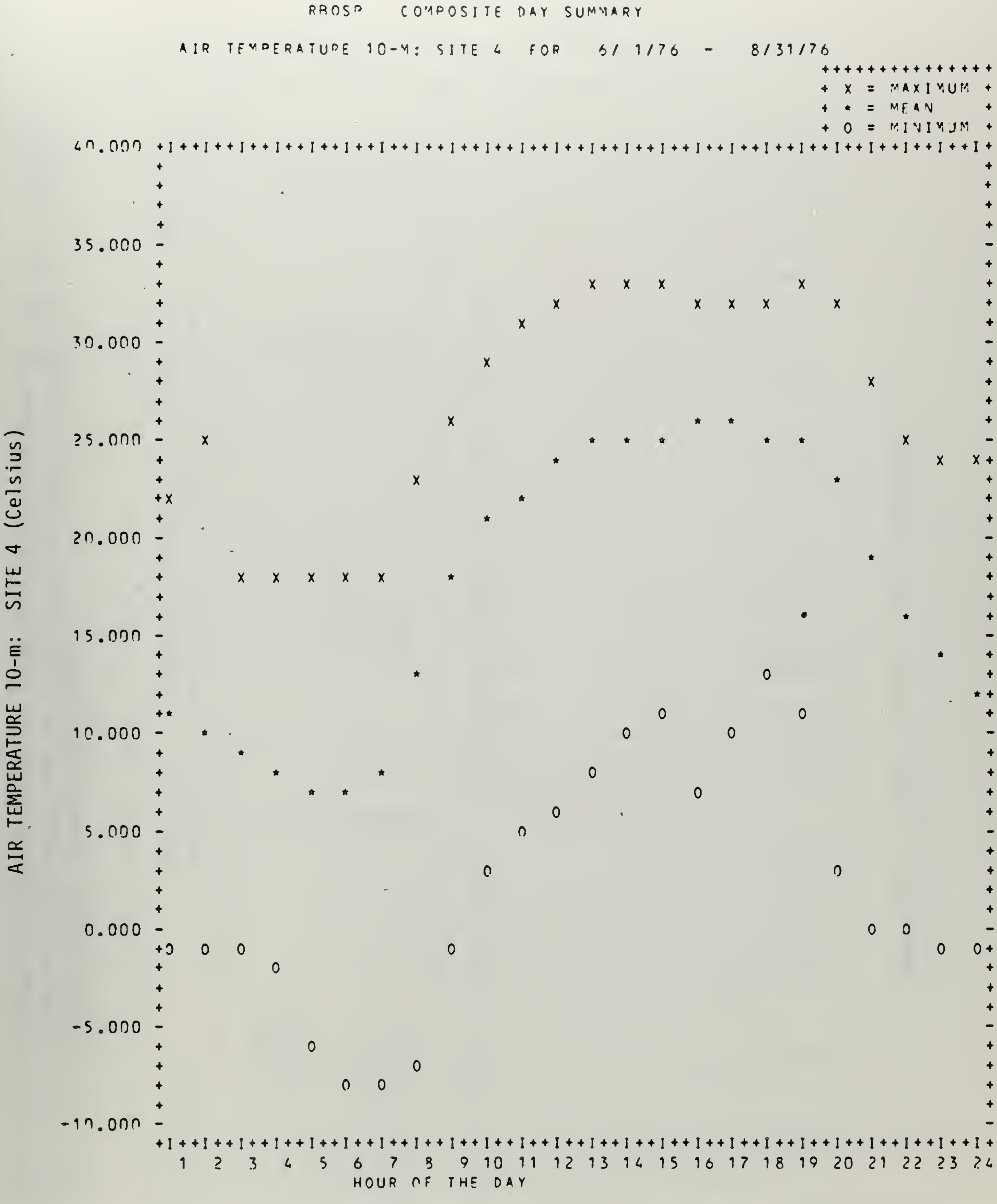

Figure 2.2-13. Air Temperature, 10-m level (minimum, maximum, and mean by hour of the day) for Summer 1976, at Site 4, RBOSP.

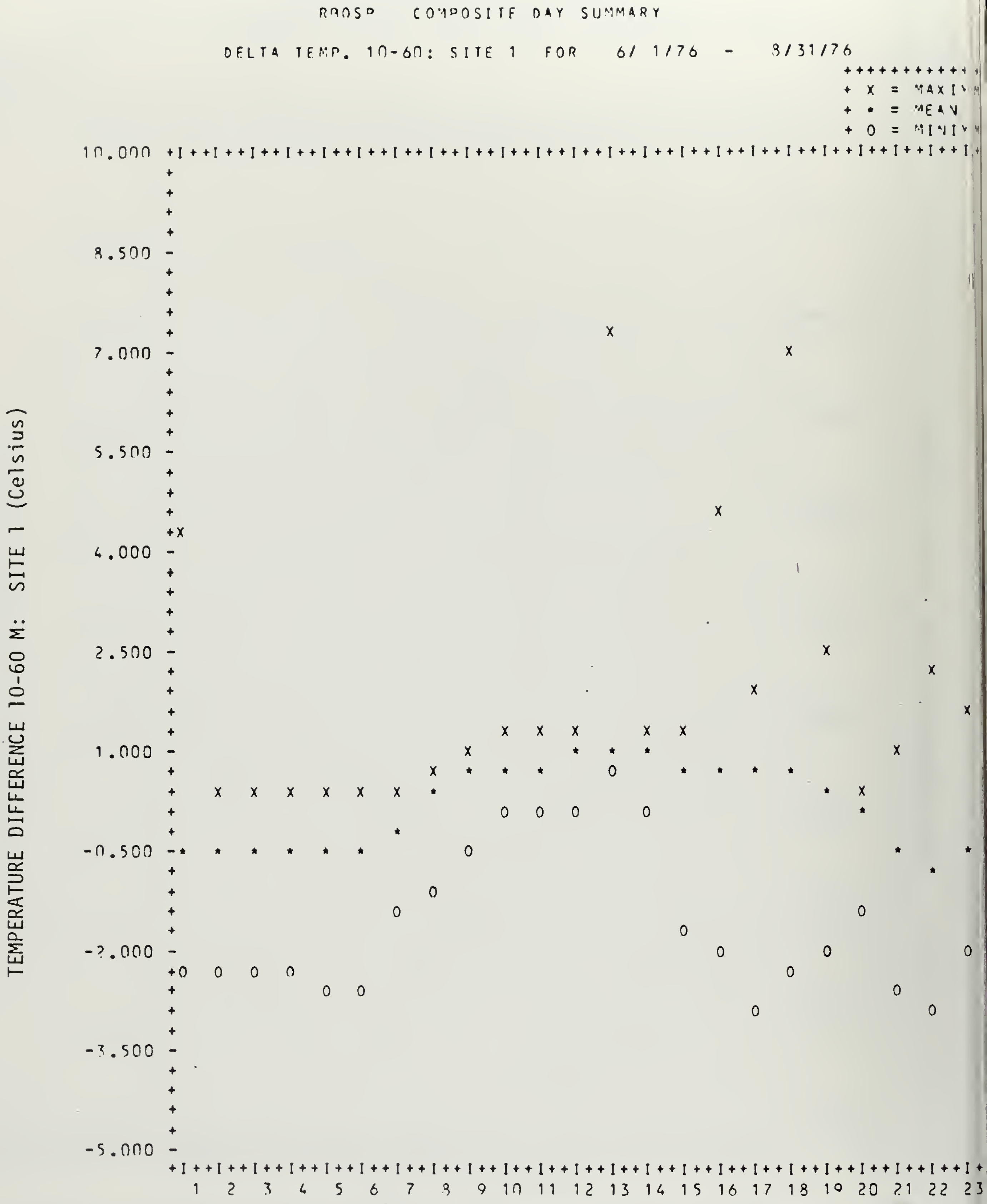

Figure 2.2-14. Temperature difference between 10-m and 60-m levels (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 1, RBOSP.

Table 2.2-2. Percent of occurrence of the Pasquill stability classes at Site 1. Stability category determined from the temperature difference between the 10- and 60-m levels during Summer 1976, RBOSP.

Stability Classification	Pasquill Categories	Temperature Change with Height (C/100m)	Percent of Occurrence	Mean Wind Speed (mph)
Extremely Unstable	A	Less than -1.9	13.28	11.64
Moderately Unstable	B	-1.9 to -1.7	5.97	10.92
Slightly Unstable	C	-1.7 to -1.5	6.97	9.65
Neutral	D	-1.5 to -0.5	23.80	8.11
Slightly Stable	E	-0.5 to 1.5	34.33	5.59
Moderately Stable	F	1.5 to 4.0	14.27	7.18
Extremely Stable	G	Greater than 4.0	1.38	8.25

SOURCE: David H. Slade, Editor. Meteorology and Atomic Energy Nat. Tech. Serv. TID-24190, pp. 102-103, 1971.

Figure 2.2-15 graphically presents the minimum, maximum, and mean composite day relative humidities as a function of hour of day for Summer 1976. The relative humidity data were taken at the 10-m level at Site 1. There was a significant decrease (6%) in the mean relative humidity at sunrise. The effect is probably due to the surface heating of the air. This composite daily transition period occurs over 2 hours. The decrease may also arise from the increased thermally generated turbulent mixing caused by the reversal of the mean lapse rate from slightly stable to slightly unstable and the increased surface temperature.

2.2.3 Miscellaneous

The meteorological parameters grouped into this category are precipitation, evaporation, solar radiation, noise, visibility, snowcourse, and tracer studies. All these parameters, except precipitation, tracer studies, and evaporation, are measured only at Site 1. Evaporation measurement is made at Site 3 because of water availability. The evaporation rate and visibility are not monitored continuously, but are recorded on a routine basis.

2.2.3.1 Precipitation Measurements

The precipitation data summary for the tipping bucket precipitation gage for Summer 1976 is presented in Table 2.2-3. The total and daily amounts of precipitation are shown for each site. Maximum total precipitation for 1 day was 0.94 inch at Site 4 on 8 August 1976. Site 2 registered the largest total precipitation (3.54 inches for Summer 1976).

Shielded weighing precipitation gages were installed at Sites 1 and 2 during the summer quarter. Data collection from these gages began on 30 June 1976. A summary of the shielded weighing precipitation gage data is presented in Table 2.2-4.

A comparison of the weighing and tipping bucket precipitation data from these sites shows that, for the most part, the amount of precipitation measured by the two types of gages is similar. Over the two month period for which data were collected using both types of gages, the difference between the precipitation measured by the tipping bucket gage compared with that measured by the weighing gage was greater at Site 1 (30% lower) than at Site 2 (6% lower).

2.2.3.2 Evaporation Measurements

Data for Summer 1976 are presented in Table 2.2-5. Measurements were started for the 1976-1977 baseline data year with the measurement on 30 April 1976. The highest evaporation rate recorded was 0.031 g/cm^2/hr. This occurred during the week ending 11 June 1976. The minimum evaporation rate was 0.014 g/cm^2/hr occurring during the measurement period ending 18 June 1976.

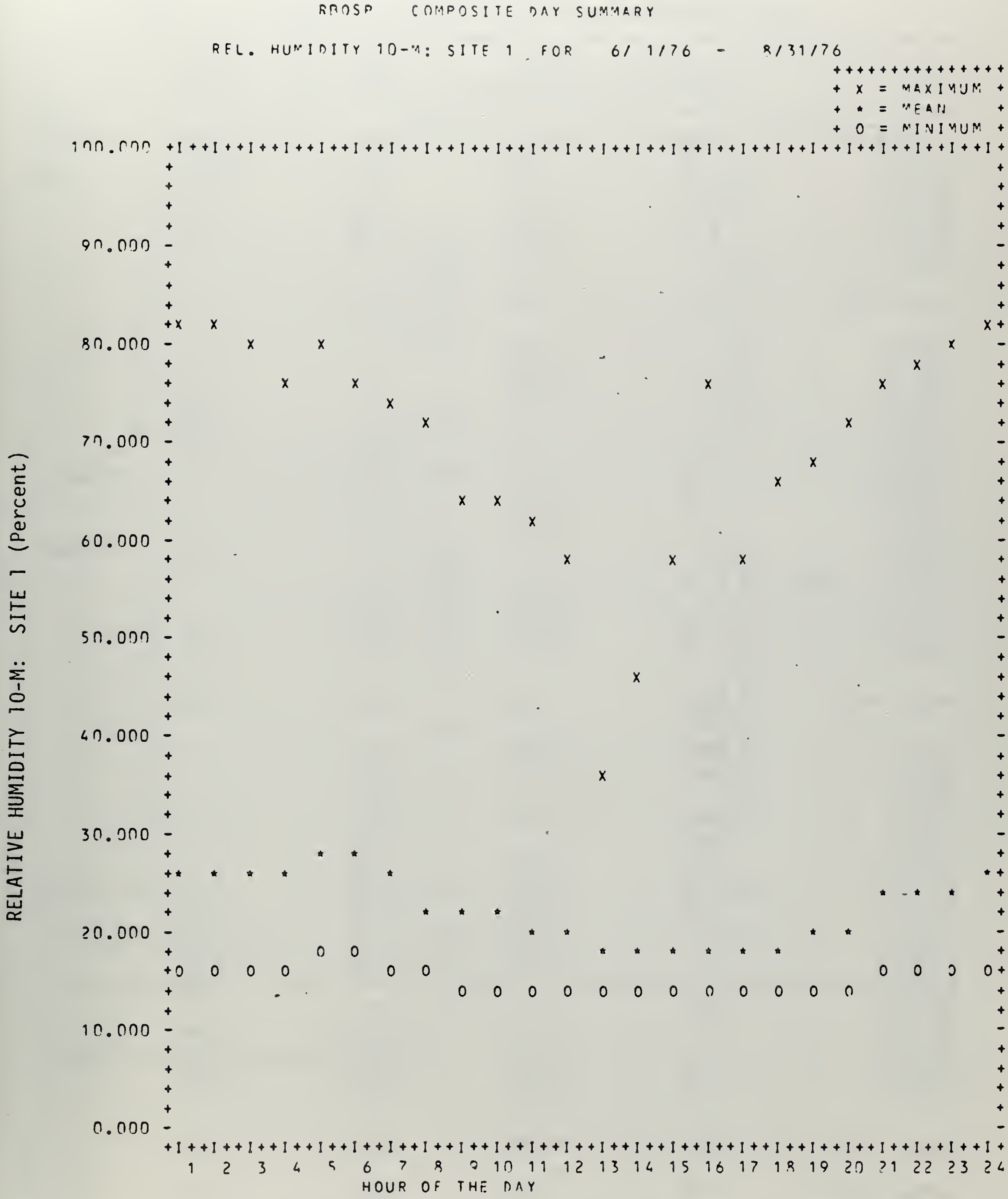

Figure 2.2-15. Relative humidity, 10-m level (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 1, RBOSP.

Table 2.2- 3. Precipitation data collected by tipping bucket gage for Summer 1976, RBOSP.

(Values are presented in inches of water)

Date	Site 1 Total	Site 2 Total	Site 3 Total	Site 4 Total
6/11/76	0.09	0.08	0.12	0.01
6/13/76	0.42	0.09	0.03	0.32
6/14/76	0.10	0.45	0.43	0.09
6/16/76	0.15	0.13	0.16	0.10
6/17/76	0.72	0.25	0.20	0.24
6/22/76	--	0.54	0.14	0.65
June Total	1.48	1.54	1.08	1.41
7/7/76	--	0.05	--	0.01
7/9/76	--	0.04	--	--
7/11/76	--	0.01	--	0.09
7/12/76	--	--	--	0.30
7/13/76	0.01	--	0.01	0.01
7/17/76	0.04	0.10	0.33	--
7/18/76	0.08	0.21	0.18	--
7/19/76	--	0.01	--	--
7/20/76	0.04	0.01	0.01	--
7/23/76	--	--	--	0.01
7/25/76 -7/26/76	0.45	0.21	0.01	--
7/27/76	--	0.03	0.02	--
7/30/76	0.13	0.18	0.01	0.03
7/31/76	0.05	0.17	0.26	0.42
July Total	0.80	1.02	0.83	0.87
8/1/76	0.01	0.05	0.03	--
8/2/76	0.01	0.08	0.06	--
8/4/76	--	--	0.01	--
8/8/76	0.08	0.10	0.05	0.94
8/9/76	--	--	0.01	--
8/10/76	0.06	0.04	0.05	0.12
8/11/76	0.04	0.49	0.08	0.01
8/13/76	0.01	0.05	0.01	0.03
8/17/76	0.01	0.02	0.03	0.01
8/18/76	--	0.01	0.03	0.01
8/20/76	--	--	--	0.08
8/21/76	0.02	--	--	--
8/22/76	0.11	--	0.13	0.08
8/23/76	--	0.01	--	--
8/24/76	0.16	0.12	0.11	0.05
8/27/76	--	0.01	0.01	--
August Total	0.51	0.98	0.61	1.31
Summer Total	2.79	3.54	2.52	3.61

Table 2.2-4. Precipitation data collected by weighing gage for Summer* 1976, RBOSP

(Values are presented in inches of water)

Date	Site 1	Site 2
July 7 1976		0.05
9		0.05
11		0.02
13	0.02	
17	0.10	0.17
18	0.17	0.22
20	0.03	
25	0.43	0.06
26		0.16
27		0.02
30	0.13	0.18
31	0.10	0.20
July Total	0.98	1.13
August 1	0.03	0.05
2	0.02	0.07
8	0.09	0.10
10	0.05	0.05
11	0.07	0.50
13		0.05
17	0.04	0.03
21		999.0
22	0.25	999.0
23		999.0
24		999.0
26	0.17	0.14
30		999.0
31		999.0
August Total	0.72	0.99
July and August Total	1.70	2.12

* Measurements started on 6/30/76

Table 2.2-5. Evaporation data summary for Summer, 1976, RBOSP.

End Date of Measurement Period	Time of Measurement Hours (MST)	Precipitation Since Last Reading (in.)	Maximum Temperature Since Last Reading (C)	Minimum Temperature Since Last Reading (C)	Water Required To Fill Pan (in.)	Evaporation Rate (g/cm^2/hr)
6/4/76	1230	0.07	24^0	5.5^0	1.20	0.023
6/11/76	1450	0	25^0	7^0	2.10	0.031
6/18/76	1410	0.94	22^0	3^0	0	0.014
6/25/76	1800	0.47	26^0	3^0	1.52	0.029
7/2/76	1746	0	29^0	12^0	1.95	0.030
6/9/76	1300	0	29^0	9^0	1.47	0.023
7/16/76	1630	0	29^0	10^0	1.73	0.025
7/24/76	2000	0.49	22^0	12^0	1.61	0.027
7/30/76	1200	0.03	27^0	11^0	0.75	0.015
8/6/76	1815	0.36	28^0	8^0	1.20	0.023
8/14/76	0930	0.19	26^0	8^0	1.25	0.020
8/21/76	1100	0.06	25^0	7^0	1.76	0.027
8/28/76	1200	0.25	25^0	7^0	0.96	0.018

2.2.3.3 Solar Radiation Measurement

Solar radiation data were taken at 1.2 m above ground level at Site 1. The minimum, maximum and mean composite day solar radiation measurements as a function of hour of the day for Summer 1976 are graphically presented in Figure 2.2-16. The seasonal and hourly minimum, maximum and mean values of the solar radiation are presented in Table 2.2-6.

2.2.3.4 Noise Measurements

2.2.3.4.1 Objectives

Baseline ambient noise levels are measured to establish a predevelopment reference to which noise levels during future operations can be compared.

2.2.3.4.2 Methods

Sound level measurements were conducted during the period 24 August through 26 August 1976 at the four sampling measurement locations (air quality towers). Daily samples were made during morning (0700-1200), afternoon (1200-1800), evening (1800-2200) and nighttime (2200-0700).

Noise was measured on a General Radio omnidirectional, 1-inch electric condenser microphone with windscreen, a General Radio Type 1933 sound level meter and octave band analyzer and a Nagra 4.2L single-track tape recorder.

2.2.3.4.3 Results

The results of the study were similar to those of the first study undertaken almost 1 year ago. Wind played an important factor in background noise, increasing the measurements 10 to 15 dB higher than during similar periods without wind. This phenomenon partially accounts for the 10 to 20 dB difference between the two programs.

A 24-hour integrated summary of ambient sound data for Rio Blanco appears in Table 2.2-6(a). Meteorological conditions varied considerably over the sample period. Temperature varied from 5.5 to 29.4 C, relative humidity varied from 10% to 88%, wind velocity ranged from 0 to 10 km/hr and wind direction was either variable or from the northwest.

2.2.3.5(a) Visibility Measurements (On Tract)

During Summer 1976, sector visibility ranged from 2 to 150 miles for each period that data were recorded. The 2-mile visibility occurred on 11 August 1976 (Tables 2.2-7 through 2.2-9).

TABLE 2.2-6

SUMMARY OF AMBIENT SOUND DATA OF 24 HOUR PERIOD
RIO BLANCO TRACT C-a - AUGUST 24 THROUGH AUGUST 26, 1976

24-hour Integrated Average*

Octave Band	Location 1			Location 2			Location 3			Location 4		
Center Freq. Hz	L_{95}	L_{eq}	L_5	L_{95}	L_{eq}	L_5	L_{95}	L_{eq}	L_5	L_{95}	L_{eq}	L_5
31.5	47.3	64	70.3	53.9	68.1	73.3	37	56.3	62.9	36.4	47.9	55.1
63	46.2	52.7	57.6	46.4	55.7	61.2	42.8	47	50.7	41.1	41.8	44.6
125	32.8	43.5	48.6	34.1	45.6	50.9	32.1	41.6	46.3	29.7	35.6	40.9
250	33.2	37.1	40.8	33.7	37.8	42.6	30.2	37	41.8	26.1	30.6	36.4
500	32.6	34.9	33.6	31.7	32.3	33.7	29.1	31.6	32.6	24	25.7	29.7
1000	32.2	32.8	32.2	31.7	31.7	31.7	29.1	30.1	29.3	24	24.2	24.8
2000	32.2	32.9	32.3	31.7	31.7	31.7	29.1	29.5	29.1	24	24	24
4000	32.2	32.6	33.1	31.7	31.8	31.8	29.1	29.3	29.1	24	24	24
8000	32.2	33	34.7	31.7	31.8	31.9	29.1	29.2	29.1	24	24	24
16000	32.2	32.3	32.5	31.7	31.7	31.9	29.1	29.1	29.1	24	24.2	24
A-wt	31.3	37.8	40.1	31.8	36.9	41.1	29	34.5	39.5	25.9	29.1	33.2
L_{dn}		42			45			36.7			34.1	

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*See Appendix A for a discussion of nomenclature

2.2.3.5(b) Visibility Measurements (Piceance Creek Basin)

2.2.3.5.1 Objectives

The objectives of the visibility program for the Piceance Creek Basin were described in Section 2.2.3.5.1(b) of Progress Report 5 - Summary.

2.2.3.5.2 Methods

The methods for this program were described in Section 2.2.3.5.2 (b) of Progress Report 5 - Summary. Methods for the basin-wide visibility studies vary from those used in the Tract C-a visibility studies. These methods were presented in Progress Report 2.

2.2.3.5.3 Results

Visual ranges obtained during the summer period (June, July and August 1976) were generally high; 95% of the measurements were greater than 51 miles and 50% were greater than 77 miles. Daily mean visual ranges varied less than 30 miles during the period; variations in mean hourly visual ranges were less than 25 miles in each view. The generalized visibility (mean visual range) was found to be 79 miles for the summer season. A summary for the summer visibility measurements is as follows.

VISUAL RANGE SUMMARY (Miles)

Piceance Creek Basin, Colorado

Summer 1976

VIEW	MEAN	MAXIMUM	MINIMUM	5 PERCENTILE*	STANDARD DEVIATION
I	82	138	57	52	20.0
II	72	128	45	46	16.6
III	76	117	49	51	17.2
IV	85	147	50	61	23.3
Composite	79	147	45	51	20.0

* 5 Percentile is that value above which occur 95% of the measurements.

2.2.3.7 Snow Course Measurements

No snow course measurements were taken during Summer 1976.

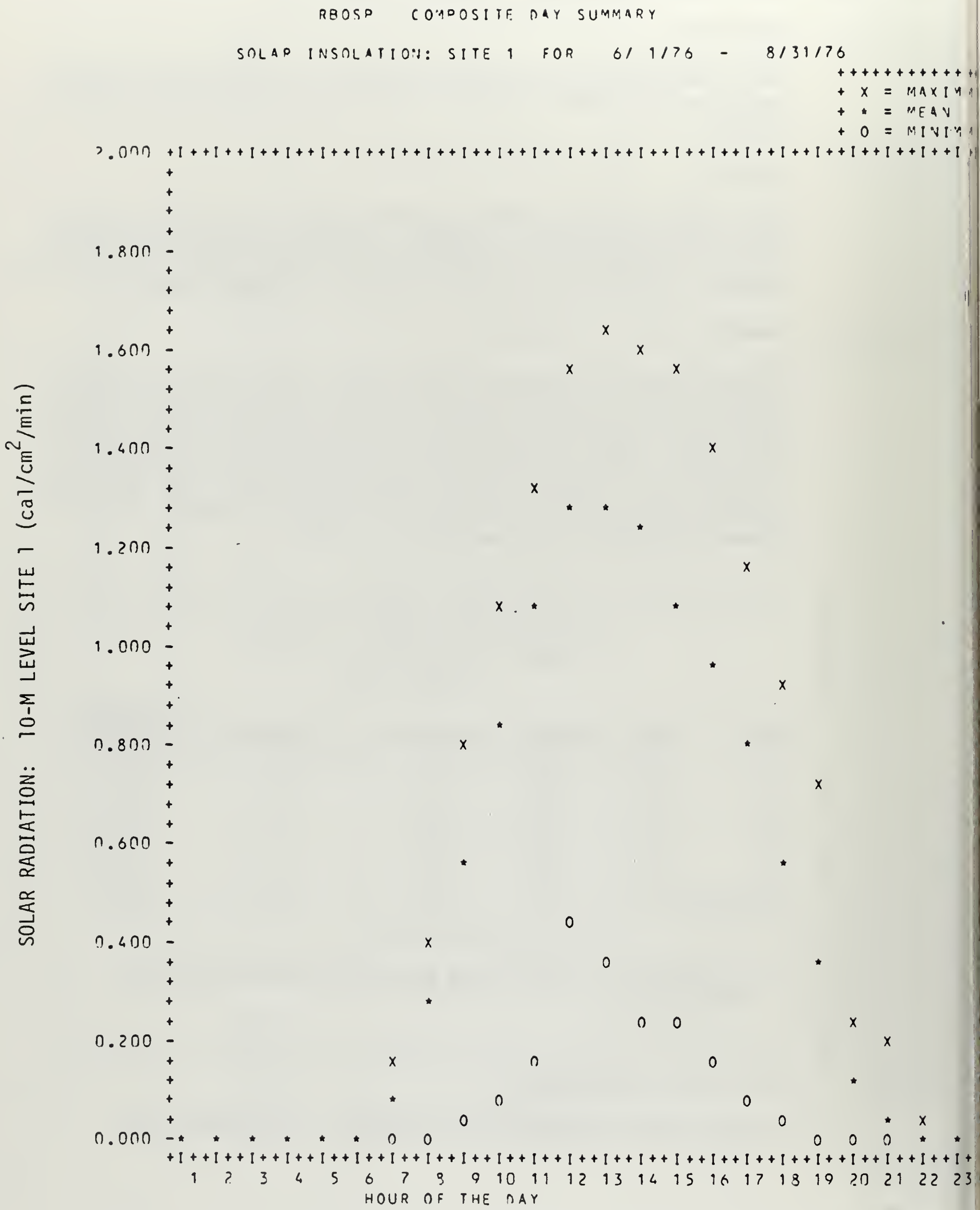

Figure 2.2-16. Solar radiation (minimum, maximum, and mean by hour of the day) for Summer 1976 at Site 1, RBOSP.

Table 2.2-7 Solar radiation, seasonal and monthly summary for Summer 1976, values are in Langleys or cal/cm^2/min, RBOSP.

	June	July	August	Summer 1976
Minimum	0.00	0.00	0.00	0.00
Maximum	1.63	1.57	1.52	1.63
Mean	0.48	0.43	0.40	0.44

Table 2.2-8 Visibility data for June 1976, RBOSP.

Date of Observation	Time of Observation Hours (MST)	Precipitation in Prior 24 hrs (in.)	Sector Visibility N	Sector Visibility E	Sector Visibility S	Sector Visibility W	Prevailing Visibility (miles)	Comments
6/3/76	1220	0	100	100	100	100	100	Est. cloud cover 70%
6/6/76	1430	0	50	50	50	50	50	Est. cloud cover 80%
6/9/76	1230	0	100	100	100	100	100	Est. cloud cover 30%
6/12/76	1200	0	100	100	100	100	100	Est. cloud cover 70%
6/15/76	1200	0	100	100	100	100	100	Est. cloud cover 0%
6/18/76	1040	0.65	100	100	100	100	100	Est. cloud cover 50%
6/21/76	1600	0	100	100	100	100	100	Est. cloud cover 10%
6/24/76	1500	0	100	100	100	100	100	Est. cloud cover 5%
6/27/76	1500	0	60	60	60	60	60	Est. cloud cover 10%
6/30/76	1400	0	100	100	100	100	100	Est. cloud cover 70%

Table 2.2-9. Visibility data for July 1976, RBOSP.

Date of Observation	Time of Observation Hours (MST)	Precipitation in Prior 24 hrs (in.)	Sector Visibility				Prevailing Visibility (miles)	Comments
			N	E	S	W		
7/3/76	1400	0	100	100	100	100	100	Est. cloud cover 15%
7/6/76	1400	0	80	80	80	80	80	Est. cloud cover 65%
7/9/76	1400	0	100	100	100	100	100	Est. cloud cover 70%
7/12/76	1200	0	100	100	100	100	100	Est. cloud cover 75%
7/15/76	1430	0	100	100	100	100	100	Est. cloud cover 5%
7/18/76	1430	0.07	60	60	60	60	60	Est. cloud cover 50%
7/21/76	1830	0	100	100	100	100	100	Est. cloud cover 10%
7/24/76	1620	0	100	100	100	100	100	Est. cloud cover 45%
7/27/76	1200	0	80	80	80	80	80	Est. cloud cover 45%
7/30/76	1515	0.07	70	70	70	70	70	Est. cloud cover 30%

Table 2.2-10 Visibility data for August 1976, RBOSP.

Date of Observation	Time of Observation Hours (MST)	Precipitation in Prior 24 hrs (in.)	Sector Visibility N	E	S	W	Prevailing Visibility (miles)	Comments
8/2/76	1600	0.14	100	100	100	100	100	Est. cloud cover 75%
8/5/76	1100	0	>80	>80	>80	>80	>80	Est. cloud cover 5%
8/8/76	1300	0	80	80	80	80	80	Est. cloud cover 70%
8/11/76	1500	0.06	60	15	60	2	15	Est. cloud cover 80%
8/14/76	1230	0.01	150	150	150	150	150	Est. cloud cover 0%
8/17/76	1330	0	80	80	80	80	80	Est. cloud cover 70%
8/20/76	1430	0	80	80	80	80	80	Est. cloud cover 75%
8/23/76	1345	0.11	80	80	80	80	80	Est. cloud cover 60%
8/26/76	1040	0	10	>80	>80	10	>80	Est. cloud cover 75%
8/29/76	1200	0	80	80	80	80	80	Est. cloud cover 15%

2.3 TERRESTRIAL STUDIES

2.3.1 Vegetation

Ten different vegetation types were sampled on or near Tract C-a during July 1976 (summer quarter). The herbaceous stratum was sampled in all 10 vegetation types along 35 permanent transects during July 1976 while 27 non-permanent transects were surveyed for shrub-seedling and mature tree stratum data in the ten vegetation types during the same period.

Important parameters describing the structural and compositional nature of each stratum within each vegetation type are presented and discussed.

Table 3-7-3 of the Second Annual Report (RBOSP, 1976) provides a comprehensive list of vegetative species encountered on the Tract C-a study area. New plant species encountered on the study area subsequent to the publication of the Second Annual Report are listed in Quarterly Reports. Table 2.3-1 of this quarterly report lists the new plant species encountered on the Tract C-a study area this quarter.

Aspen - During the summer quarter the aspen type was sampled by two permanent and one non-permanent transects. Three strata and 31 different species were identified for the aspen type during July 1976 sampling: 2 species in the mature tree stratum; 7 species in the shrub-seedling stratum; and 24 species in the herbaceous stratum. Quaking aspen and Douglas-fir occurred in both the shrub-tree seedling and mature tree strata.

The aspen vegetation type was sampled over an elevational range of 2481 to 2652 m (8140 to 8700 ft) where it occurs primarily on deep, loamy soils which are high in organic matter.

The mature tree stratum consisted of two species, quaking aspen and Douglas-fir and contributed a total cover of 81%. Quaking aspen dominated the mature tree stratum and provided a relative cover of 91% a density of 383 individuals per hectare and a basal area of 12.8 m^2 per hectare.

Seven shrub-tree seedling species contributed a total cover of 49% and a total density of 7767 individuals per hectare during July 1976 sampling of the aspen shrub-tree seedling stratum. Mountain snowberry, wood's rose and Utah serviceberry were the dominent species contributing 45% of the total cover.

The herbaceous stratum was composed of 24 different species contributing a total cover of 5%. Mountain Thermopsis and elk sedge were the dominant herbaceous species contributing nearly 2% of the total herbaceous cover.

Table 2.3-1. Additions to the list of plant species observed during July, 1976 in the vicinity of Tract C-a for RBOSP (see Section 7.1.A, Table 3-7-3 of the Second Annual Report, 1976)

Abbreviation	Species
	FORBS
Chre[1]	*Chenopodium rubrum* L.[2]; (Chenopodiaceae)[3], Ther[4], Goosefoot, V[5], (N)[6]
Disp	*Distichlis spicata* Torr. Rydb.; (Graminae), Hemi, Inland Saltgrass, (N)
Hagl	*Halogeton glomeratus* Bieb. Mey.; (Chenopodiaceae), Ther, Halogeton, V (I)

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[1] Abbreviation of genus and species in a four-letter code.

[2] Author citation, nomenclatural authority cited after each species name and delineated by a semicolon.

[3] The family of plants to which a species belongs in parentheses.

[4] Lifeforms of Plants

Phan (Phanerophyte) - Perennating bud at least 0.25 m above soil surface.

Cham (Chamaephyte) - Perennating bud between 0 and 0.25 m above soil surface.

Hemi (Hemicryptophyte) - Perennating bud in soil surface.

Cryp (Cryptophyte) - Perennating buds covered by soil or water.

Ther (Therophyte) - Annual plants, perennating buds contained in seed.

Succ (Succulent) - Stems enlarged; serve as water storage organ.

[5] (V) - Voucher specimen collected.

[6] Origin of plant species

(N) - Native to the North American continent.

(I) - Introduced from outside the North American continent.

Douglas Fir - The Douglas-fir type was sampled during July, 1976 by 2 permanent and one non-permanent transects. Three strata and 24 different species were identified for the Douglas-fir type during July, 1976 sampling: one species in the mature tree stratum; 6 species in the shrub-tree seedling stratum; and 18 species in the herbaceous stratum. Douglas-fir was encountered in both the shrub-tree seedling and mature tree strata.

The Douglas-fir vegetation type was sampled over an elevational range of 2378 to 2591 m (7800 to 8500 ft) where it occurrs on steep slopes with shallow soils.

The mature tree stratum contained only one species, which contributed a total cover of 68%, occurred at a density of 333 individuals per hectare and had a basal area of 13.6 m^2 per hectare (Douglas fir).

Six shrub-tree seedling species contributed a total cover of 31% and a total density of 20,550 individuals per hectare in the Douglas-fir shrub-tree seedling stratum. Mountain snowberry and Utah serviceberry were the dominant shrub species contributing 24% of the total cover in the shrub-tree seedling stratum.

The Douglas-fir herbaceous stratum was composed of 18 different species contributing a total cover of 3%. Elk sedge was the dominant species contributing over 1% of the total herbaceous cover.

Mixed Brush - During the summer quarter the mixed brush vegetation type was sampled with five permanent and four non-permanent transects. Three strata and 52 different species were identified for the mixed brush type during July, 1976 sampling: 2 species in the mature tree stratum; 15 species in the shrub-tree seedling stratum; and 37 species in the herbaceous stratum. Pinyon-pine and Douglas-fir occurred in both the mature tree and shrub-tree seedling strata.

The mixed brush vegetation type was sampled over an elevational range of 2189 to 2561 m (7180 to 8400 ft) where it occurs on soils ranging from shallow to moderately deep depending on the slope of the area sampled.

The sparse mature tree stratum was comprised of two species, pinyon-pine and Douglas-fir which contributed a total cover of only slightly more than 1% and a total density of 12.5 individuals per hectare. Douglas-fir occurred at a greater density and frequency than pinyon-pine.

Fifteen shrub-tree seedling species comprised the shrub-tree seedling stratum where they contributed a total cover of 65%. Utah serviceberry was the dominant shrub species contributing 29% of the total shrub cover.

The herbaceous stratum was comprised of 37 species which contributed a total cover of slightly over 1%. Elk sedge was the dominant herbaceous species providing a relative cover of 38%.

Pinyon-Juniper - During the summer quarter, the pinyon-juniper vegetation type was sampled with seven permanent and eight non-permanent transects. Three strata and 54 different species were identified for the pinyon-juniper type during July, 1976 sampling: 2 species in the mature tree stratum; 15 species in the shrub-tree seedling stratum; and 37 species in the herbaceous stratum. Pinyon pine and Utah juniper occurred in both the mature tree and shrub-tree seedling strata.

The pinyon-juniper vegetation type was sampled over an elevational range of 1987 to 2262 m (6520 to 7420 ft) where it occurred primarily on shallow, well drained soils derived from sandstone.

The mature tree stratum was comprised of 2 species, pinyon pine and Utah juniper which contributed a total cover of 22.6% and a total density of 220.8 individuals per hectare. Utah juniper occurred at a greater density and frequency than pinyon pine though the latter showed slightly higher percent cover.

Fifteen shrub-tree seedling species comprised the shrub-tree seedling stratum where they contributed a total cover of 11.2%. Big sagebrush and true mountain mahogany were the dominant shrub species together contributing over 5% of the total shrub cover.

The herbaceous stratum was comprised of 37 species which contributed a total cover of only 0.6%. Two grasses, slender wheatgrass and Sandberg bluegrass were the dominant herbaceous species providing a relative cover of over 45%.

Sagebrush - During the summer quarter the sagebrush vegetation type was sampled with seven permanent and eight non-permanent transects. Two strata and 65 different species were identified for the sagebrush type during July, 1976 sampling: 13 species in the shrub-tree seedling stratum; and 52 species in the herbaceous stratum. No mature trees were encountered on the non-permanent transects.

The sagebrush vegetation type was sampled over an elevational range of 1957 to 2600 m (6420 to 8530 ft) where it occurred on well-drained soils ranging from shallow to deep depending on the topography of the area sampled and on the origin (alluvial or sandstone derived) of the soil.

Thirteen shrub-tree seedling species comprised the shrub-tree seedling stratum where they contributed a total cover of over 36%. Big sagebrush was the dominant shrub species contributing almost 27% of the total shrub cover.

The herbaceous stratum was comprised of 52 species which contributed a total cover of just under 2%. Sandberg bluegrass and elk sedge were the dominant herbaceous species together providing a relative cover of over 37%.

Greasewood - During the summer quarter the greasewood vegetation type was sampled on three permanent transects. Greasewood was not sampled with non-permanent transects during July since all available greasewood stands have already been sampled. As discussed in the Second Annual Report (RBOSP, 1976; page 3-7-41), greasewood is considered an association within the sagebrush type.

The greasewood vegetation association was sampled over an elevational range of 1905 to 2134 m (6250 to 7000 ft) where it occurs on deep, well-drained alluvial soils.

The herbaceous stratum on the three permanent transects was comprised of 12 species which contributed a total cover of less than 2%. The dominant herbaceous species providing a relative cover of over 76% were cheatgrass brome, bluestem wheatgrass, lambsquarter goosefoot, and summer cypress.

Rabbitbrush - During the summer quarter rabbitbrush was sampled on two permanent transects. No non-permanent transects were sampled in rabbitbrush in July 1976. As discussed in the Second Annual Report (RBOSP, 1976; page 3-7-43), rabbitbrush is considered a seral stage in the bottomland sagebrush association. Few stands of rabbitbrush in the study area remain unsampled to date.

The rabbitbrush vegetation association was sampled over an elevational range of 2012 to 2073 m (660 to 6800 ft) where it occurs on deep, well-drained alluvial soils.

The herbaceous stratum along the 2 permanent transects was comprised of 10 species which contributed a total cover of somewhat less than 7%. Great Basin wildrye was the dominant herbaceous species providing a relative cover of over 79%.

Bald (Upland Meadow) - During the summer quarter the bald vegetation type was sampled with two permanent and three non-permanent transects. Two strata and 39 different species were identified for the bald type during July, 1976 sampling: 8 species in the shrub-tree seedling stratum; and 31 species in the herbaceous stratum.

The bald vegetation type was sampled over an elevational range of 2256 to 2600 m (7400 to 8530 ft) where they occurred on shallow, well-drained soils derived from sandstone.

Eight shrub-tree seedling species comprised the shrub-tree seedling stratum where they contributed a total cover of 1.9%. Gray horsebrush was the dominant shrub species contributing almost 0.6% of the total shrub cover.

The herbaceous stratum was comprised of 31 species which contributed a total cover of almost 2.5%. Sandberg bluegrass was the dominant herbaceous species providing a relative cover of over 26%.

Shadscale - During the summer quarter the shadscale vegetation type was sampled with two permanent transects. Because of its limited distribution in the area, no non-permanent shadscale transects were sampled in July 1976; hence, data for the shrub-tree seedling and mature tree strata were not gathered.

The shadscale vegetation type was sampled over an elevational range of 2027 to 2076 m (6650 to 6810 ft) where it occurred on shallow soils derived from sandstone and platy siltstone outcrops.

The herbaceous stratum was comprised of 8 species which contributed a total cover of just over 0.5%. Fringed sage and eriogonum were the dominant herbaceous species together providing a relative cover of over 72%.

Riparian - During the summer quarter the riparian vegetation type was sampled with three permanent and two non-permanent transects. Two strata and 34 different species were identified for the riparian type during July, 1976 sampling: 21 species in the herbaceous stratum; and 13 species in the shrub-tree seedling stratum.

The riparian vegetation type was sampled over an elevational range of 1935 to 2195 m (6350 to 7200 ft) where it occurred on deep, well-drained alluvial soils.

Thirteen shrub-tree seedling species comprised the shrub-tree seedling stratum where they contributed a total cover of over 36%. Big sagebrush was the dominant shrub species contributing over 11% of the total shrub cover.

The herbaceous stratum was comprised of 21 species which contributed a total cover of over 8.5%. Quackgrass and Great Basin wildrye were the dominant herbaceous species providing a relative cover of over 77%.

2.3.2 Grazing Exclosure

Grazing exclosure sampling was conducted during August 11-18, 1976. Grass-forb stratum data collected during this period are presently being analyzed. Photoplot photographs are being printed for analysis.

Circular shrub plot data have been summarized for the four grazing exclosure study compartments (including the external "control" compartment). Sagebrush (Artemisia tridentata) was the dominant shrub species in three of the four compartments representing 100%, 62%, and 40% of the shrubs in compartments A, B, and C, respectively. Green rabbitbrush (Chrysothamnus viscidiflorus) and bitterbrush (Purshia tridentata) comprised an additional 43% of the shrubs in compartment C and bitterbrush and sagebrush comprised 45% and 43%, respectively, of the shrubs in compartment D (the control).

The mature tree stratum data show that the upper canopy cover was 34% and 18% of the line in compartment A for pinyon pine (Pinus edulis) and juniper (Juniperus osteosperma), respectively, while lower canopy cover in that compartment was only 6% and 10% for the same two species. Compartment B showed 5% and 1% upper canopy cover along the transect for pinyon and juniper, respectively, and 6% and 2% lower canopy cover for the same two tree species. Compartment C showed 5% and 13% upper canopy cover for pinyon and juniper, respectively, and 6% and 5% lower canopy cover for the same two species. Compartment D showed 5% and 1% upper canopy cover along the line for pinyon and juniper, respectively, and 8% lower canopy cover for pinyon.

Grazing exclosure data are intended to be collected and compared over a period of years to reveal long-term trends of production and use. The RBOSP final report will summarize the comparison of the first two years (1975 and 1976) of grazing exclosure data gathering.

2.3.3 Small Mammals

Live Trapping - Small mammal live trapping operations were conducted during July, 1976. This sample period was characterized by very high trap success. As a result, several grids met the criteria presented in Section 7.2.A.2 of the Second Annual Report (RBOSP, 1976) for extension of trapping effort to six (grid D) or seven trap nights (grids 3, 6, 7, and E). All other grids were sampled for five trap nights. A total of 2023 individuals comprising 11 species were captured during July. This represents a trapping success of about 36%. The species captured and their percent relative abundance based on number captured per 100 trap nights are shown on Table 2.3-2.

The high trapping success encountered during July, 1976 was due mainly to the large number of captures of the deer mouse and the least chipmunk. These species exhibited abundance indices of 15.49 and 15.42 individuals per 100 trap nights which represents an approximately 300% increase from previous warm weather sample periods (October, 1974 and May, July, and September, 1975). The deer mouse and the least chipmunk also continued to dominate the trappable small mammal fauna accounting for 86.9% of all individuals captured which is similar to the 82.45 combined relative abundance shown by other warm weather samples (Table 3-7-72 of the Second Annual Report, RBOSP, 1976). Both species were represented in samples from all grids with the deer mouse captured most frequently on grid 7, upland meadow (49.35 individuals/100 trap nights) and the least chipmunk encountered more often on grid A, greasewood-sagebrush (26.92 individuals/100 trap nights). The latter species also exhibited a more equitable distribution among the different habitat types.

The golden-mantled ground squirrel was the third most frequently captured small mammal during July, 1976 accounting for 5.29% of the total captures. The July trapping record for this species substantiates a trend indicated by the data for the deer mouse and the least chipmunk; the percent relative abundance, 5.29% is similar to previous warm weather samples, 5.41%, while capture success is approximately three-fold greater, 1.88 versus 0.74 individuals per 100 trap nights. The golden-mantled ground squirrel was captured on all grids except those located in bottomland meadow, Douglas fir, and aspen. It was captured most frequently on grid B, pinyon-juniper (south slope).

The fourth most abundant small mammal during July, 1976 was the Colorado chipmunk. Though the trend is not as remarkable as the three previously discussed species, the data for this species exhibit the same pattern of an approximately 300% increase in abundance (1.76 versus 0.43 individuals/100 trap nights) without a great change in the percent relative abundance (4.95 versus 3.14%) from the other warm weather sample periods. The Colorado chipmunk was captured on all grids except four, and was most abundant on grid 6, pinyon-juniper/sagebrush.

The remaining seven small mammal species encountered during July, 1976 trapping efforts accounted for only 2.86% of the total abundance. With the exception of the red-backed vole, the differences in percent relative abundance and capture success between July and previous sampling periods for these species are not remarkable. The red-backed vole, however, showed an 82% decrease in relative abundance. Moreover, the captures of this species were limited to aspen grids whereas previously it has been captured in all three high elevation grids (aspen, Douglas fir, and mixed brush).

Table 2.3-2. Summary of trapping results for all small mammal species captured at all grids during sample period 8, July 1976, for RBOSP.

Species	# Individuals Captured	Individuals Captured Per 100 Trap Nights 1/	Relative Abundance 2/
Spermophilus tridecemlineatus (thirteen-lined ground squirrel)	20	0.35	0.98
Spermophilus lateralis (golden-mantled ground squirrel)	107	1.88	5.29
Eutamias minimus (least chipmunk)	877	15.42	43.35
Eutamias quadrivittatus (Colorado chipmunk)	100	1.76	4.95
Perognathus apache (Apache pocket mouse)	1	0.02	0.06
Peromyscus maniculatus (deer mouse)	881	15.49	43.55
Peromyscus truei (piñon mouse)	8	0.14	0.39
Neotoma cinerea (bushy-tailed woodrat)	3	0.05	0.14
Microtus longicaudus (long-tailed vole)	5	0.09	0.25

Table 2.3-2. (Continued)

Species	# Individuals Captured	Individuals Captured Per 100 Trap Nights 1/	Relative Abundance 2/
Microtus montanus (Montane vole)	8	0.14	0.39
Clethrionomys gapperi (red-backed vole)	13	0.23	0.65
TOTAL	2,023	35.93	

1/ Trap night - one trap baited and set for 24 hours

2/ (Number of individuals of each species/number of individuals of all species) x 100

Table 2.3-3. Shannon-Weiner diversity indices (H'), unbiased estimates of H' (E(H')), variance of H' (var (H')), maximum expected value of H' (H'(max)), and equitability (J) for all small mammal grids during sample period 8, July 1976, for RBOSP

Grid Designation	Vegetation Type	H'	E(H')	var(H')	H'(max)	J
1	Bottomland meadow	0.892	0.872	0.008	1.099	0.812
2	Sagebrush	1.185	1.161	0.003	1.386	0.855
3	Rabbitbrush	0.678	0.673	0.000	0.693	0.978
4	Pinyon-juniper/mixed brush	1.141	1.117	0.005	1.386	0.823
5	Mixed brush	0.942	0.916	0.012	1.386	0.679
6	Pinyon-juniper/sagebrush	1.189	1.163	0.005	1.609	0.739
7	Upland meadow	0.510	0.503	0.003	1.099	0.464
A	Greasewood-sagebrush	0.828	0.822	0.003	1.386	0.598
B	Pinyon-juniper (south slope)	1.312	1.298	0.004	1.792	0.732
C	Pinyon-juniper (north slope)	1.237	1.225	0.002	1.792	0.691
D	Sagebrush	0.920	0.914	0.002	1.386	0.663
E	Mixed brush	0.976	0.970	0.001	1.792	0.545
F	Douglas fir	0.904	0.893	0.003	1.099	0.823
G	Aspen	1.074	1.052	0.005	1.609	0.668

Adult weights were averaged for small mammal species captured on each grid. Only the initial capture weights were used in average weight determination. As expected, average weights are similar to those determined for other warm weather samples (see Section 7.2.A.3 in the Second Annual Report, RBOSP, 1976).

Shannon-Weiner species diversity indices are presented for each grid in Table 2.3-3. As expected from the high capture success and large number of different species captured, species diversity is generally higher for all grids than in previous warm weather sampling periods (see Section 7.2.A.3 of the Second Annual Report, RBOSP, 1976). Although some of the results are not directly comparable as a result of different trapping efforts allocated to the various grids, the grids established in pinyon-juniper again exhibited the highest diversity indices.

Pitfall Trapping - Pitfall trapping was conducted during the live trapping operation in July, 1976. In addition to species represented in live trap samples,a single sagebrush vole was captured in pitfall D, sagebrush, and a northern pocket gopher and five shrews were captured in pitfall G, aspen. The shrews are presently being identified and will be reported in the Final Report.

Stomach Analysis and Reproductive Effort - Removal trap lines were established in all the major vegetation types during July, 1976 for the collection of small mammals for stomach analysis and reproductive effort.

The specimens collected are presently being analyzed and the results will be reported in the Final Report.

Bat Mist Netting - Bats were sampled over stock tanks in the vicinity of Tract C-a during June 23-26 and August 23-26, 1976. The August data are still being analyzed. In June, 33 bats were captured comprising 6 species. The predominant species captured was the long-eared myotis, representing 42% of the total captures. Lesser numbers of the long-legged myotis, the small-footed myotis, and the big brown bat were captured. One individual each of the hoary bat and the silver-haired bat were also captured in June.

2.3.4 Large Mammals

Large mammal aerial surveys were conducted on June 10 and August 9, 1976. The number of mule deer, elk, and feral horses observed during each survey is presented in Table 2.3-4.

The majority of the few mule deer and the elk observed during this quarter were located on the high elevations west of Tract C-a. Feral horse herds ranging in size from 3 to 18 animals were observed on 84 Mesa, the southeast corner of Tract C-a, and southwest of Tract C-a on Airplane and Landing Strip Ridges.

Table 2.3-4. Number of mule deer, elk, and feral horses observed during two summer, 1975 aerial surveys conducted for RBOSP

			Feral Horses		
Date	Mule Deer	Elk	Adult	Juvenile	Unidentified
June 10, 1976	2	1	76	17	5
August 9, 1976	3	0	37	2	0

Table 2.3-5. Mule deer pellet groups accumulated during winter/spring 1975/1976 on 13 transects on and near Tract C-a for RBOSP

Transect Number	Pellet Groups Recorded	Pellet Groups Per Acre	Period of Accumulation (days)	Pellet Group Index [1]
1	9	156.8	256	0.6
2	10	174.2	257	0.7
3	8	139.4	257	0.5
4	3	52.3	257	0.2
5	13	226.5	256	0.9
6	13	226.5	256	0.9
7	8	139.4	256	0.5
8	4	69.7	257	0.3
9	8	139.4	257	0.5
10	6	104.5	257	0.4
11	5	87.1	257	0.3
12	4	69.7	257	0.3
13	6	104.5	256	0.4

[1] Pellet group index = $\frac{\text{Pellet groups/acre}}{\text{Accumulation Period}}$

Ninety-eight horses were recorded during the June, 1976 survey. The 39 horses observed during the August, 1976 survey were located on 84 Mesa, Dead Horse Ridge, north of Corral Gulch, Box Elder Gulch, and between the Right and Left Forks of Stakes Springs Draw. Herds ranged in size from 3 to 12 animals.

Pellet group counts were conducted June 2-5, 1976. The results of the pellet group plot inspection are presented in Table 2.3-5. All transects had pellet group accumulations during the winter/spring 1975-76 period. Transects 5 and 6 on the eastern part of Tract C-a showed the highest pellet group accumulations (pellet group indices of 0.9) in the study area. Pellet group accumulation on transects in the other locations was variable; transects west and southwest of Tract C-a showed relatively low pellet group indices, transects north of the tract generally had low pellet group indices but the transect (2) furthest northwest of Tract C-a showed a somewhat higher pellet group index (0.7) than other transects in the vicinity.

Transects 1 and 7, located on the western portion of Tract C-a, showed pellet group indices (0.6 and 0.5, respectively) intermediate between those of the eastern Tract C-a area and the low-index transects off Tract C-a to the northwest and south.

2.3.5 Mammalian Predators

Scent-station predator sampling was conducted during June 26-30, 1976. Results are summarized in Table 2.3-6. Havahart traps were set during this period and during the July small mammal sampling period in six vegetation types in the vicinity. Tract C-a siren-elicited howling response coyote censuses were conducted on June 25 and 27, 1976.

As shown in Table 2.3-6, scent station line A totalled 205 operable station nights ranging from 36 on day 1 to 44 on day 4. Line A stations were visited by a total of six coyotes and three weasels for indices of 29.27 and 14.63, respectively, for the two species.

Line B had 194 operable station nights ranging from 33 on day 1 to 43 on day 4. Five coyotes and two weasels were recorded for the week on this line yielding indices of 25.77 and 10.31 for coyotes and weasels, respectively.

Ten coyote siren stations were operated on two nights during June 26-30, 1976 yielding responses by 19 coyote groups at 11 stations summed over the two nights. These results yield station and group response indices of 55 and 95, respectively.

Table 2.3-6. Predator scent station results for two lines operated during July 26-30, 1976 for RBOSP.

	Sample Night					Total	Station Index 1/
	1	2	3	4	5		
LINE A							
Operable Stations	36	43	40	44	42	205	-
Stations Visited							
Coyote	2	1	1	-	2	6	29.27
Weasel	-	1	1	-	1	3	14.63
LINE B							
Operable Stations	33	38	38	43	42	194	-
Stations Visited							
Coyote	1	1	3	-	-	5	25.77
Weasel	2	-	-	-	-	2	10.31

1/ $$\frac{\text{Total No. of Visits by Species}}{\text{Total No. Operable Station Nights}} \times 1000 = \text{Index}$$

No predators were captured in Havahart live traps during the reporting quarter. Three adult weasels (Mustela sp.) were captured in Sherman live traps during July, 1976 small mammal trapping; one weasel was captured on the rabbitbrush and each of the two mixed brush grids.

2.3.7 Avifauna

2.3.7.1 General Avifauna

Strip transects and qualitative surveys were conducted June 25-29, 1976. Fifty-three species were observed during strip transects. Transect #11 (sagebrush) exhibited the lowest species diversity index (H' = 1.182). Highest density estimate (22.6 birds/ha) was recorded for Transect #15 (riparian) and the lowest density estimate (1.8 birds/ha) was recorded for Transect #7 (upland meadow).

The olive-sided flycatcher was recorded for the first time in June, 1976 on the Douglas fir transect (#13), bringing the total number of bird species observed to date in the study area to 139.

Twelve species were recorded on Transect #1 (bottomland meadow). The most abundant species were the house finch, vesper sparrow, Brewer's sparrow, and red-winged blackbird. The diversity index (H') was 2.0 for this transect (Table 2.3-7).

Ten species were recorded on Transect #2 (sagebrush). The most abundant species were the vesper sparrow, mourning dove, and Brewer's sparrow. The diversity index was 1.7 for this transect.

Although eleven species were recorded, Transect #3 (rabbitbrush) exhibited the third lowest species diversity index (H' - 1.379). This is in part attributed to the large number of Brewer's sparrows recorded during June (4.1 birds/ha). The dominance of one species caused a low equitability index (J = 0.575) and therefore, a low diversity index.

Other abundant species recorded on this transect during June were the song sparrow and green-tailed towhee.

Fifteen species were recorded along Transect #4 (pinyon-juniper/ mixed brush). This transect exhibited the third highest species diversity index (H' = 2.327). No single dominant species was recorded. However, the vesper sparrow, blue-gray gnatcatcher and black-capped chickadee were the most numerous species recorded.

Nine species were recorded along Transect #5 (mixed brush). This transect exhibited the third lowest avian density of the transects sampled in June. All species, with the exception of the green-tailed towhee, were recorded in low numbers. The diversity index was 1.9 for this transect.

Table 2.3-7. Shannon-Weiner diversity indices (H'), unbiased estimates of H' (E(H')), variance of H' (var (H')), maximum expected value of H' (H'(max)), and equitability (J) for all avifauna transects during sample period 9, June 1976

Transect Number	Vegetation Type	H'	E(H')	var(H')	H'(max)	J
1	Bottomland meadow	2.004	1.982	0.003	2.485	0.806
2	Sagebrush	1.696	1.656	0.007	2.303	0.737
3	Rabbitbrush	1.379	1.342	0.011	2.398	0.575
4	Pinyon-juniper/mixed brush	2.327	2.293	0.003	2.708	0.859
5	Mixed brush	1.870	1.824	0.004	2.197	0.851
6	Pinyon-juniper/sagebrush	2.834	2.764	0.003	3.091	0.917
7	Upland meadow	1.384	1.312	0.016	1.792	0.772
8	Greasewood-sagebrush	1.424	1.377	0.012	2.079	0.685
9	Pinyon-juniper (south slope)	2.126	2.079	0.005	2.565	0.829
10	Pinyon-juniper (north slope)	2.465	2.430	0.003	2.996	0.823
11	Sagebrush	1.182	1.157	0.009	1.792	0.660
12	Mixed brush	1.254	1.245	0.003	1.609	0.779
13	Douglas fir	1.949	1.923	0.006	2.639	0.739
14	Aspen	2.081	2.039	0.004	2.398	0.868
15	Riparian	2.325	2.307	0.001	2.833	0.821

Transect # 6 (pinyon-juniper/sagebrush) exhibited the highest species diversity index during June (H' = 2.834). This is in part attributed to the heterogeneity of the habitat providing for a greater potential for higher species diversity than those habitats such as sagebrush which are more homogeneous.

Although 22 species were recorded, all species were recorded in low numbers, consequently this habitat type exhibited a low density avian population. The most abundant species were the green-tailed towhee, gray-headed junco, and vesper sparrow.

Of the 15 transects sampled in June, 1976, Transect #7 (upland meadow) exhibited the lowest density avian population. Six species were recorded, and all were tallied in low numbers. The diversity index for this transect was 1.384. The structural composition (there is only one vegetative stratum) of the vegetation in this habitat type does not appear to provide enough food and cover for very many nesting individuals. The most abundant species observed within this habitat were the vesper sparrow, horned lark, and violet-green swallow.

Eight species were recorded on Transect #8 (greasewood-sagebrush) resulting in the second lowest density estimate of the transects sampled in June, 1976. This low density may be partially attributed to the relatively windy conditions during the period when this transect was surveyed. High winds tend to bias the data towards an underestimation of population density because of the observer's hindered ability to hear singing and calling individuals and changes in many species behavior during unfavorable weather conditions. The diversity index calculated for this transect was 1.424.

The most abundant species were Brewer's sparrows, green-tailed towhees, and Virginia's warbler.

Thirteen species were recorded along Transect #9 (pinyon-juniper/south slope). The most abundant species were the blue-gray gnatcatcher, white-breasted nuthatch, black-throated gray warbler, and mourning dove. The diversity index for this transect was 2.126.

Transect #10 (pinyon-juniper/north slope) exhibited the second highest species diversity index and second highest total density of the 15 transects sampled in June, 1976. The most abundant species were the gray-headed junco, black-throated gray warbler, and house finch. Most species recorded within this transect are common breeding species of the pinyon-juniper woodland and its associated understory. The one exception is the vesper sparrow. This species is generally a brushland species (Bailey and Niedrach, 1965) and is not typical of the pinyon-juniper woodland. However, the three individuals recorded along this transect were associated with a small stand of sagebrush located within the pinyon-juniper stand.

Transect #11 (sagebrush) exhibited the lowest species diversity index (H' = 1.182). Only six species were recorded within this transect and the distribution of individuals among these species was disproportionate (J' = 0.660). Of the six species recorded, the Brewer's sparrow was the most abundant. The other five species, green-tailed towhee, mountain bluebird, vesper sparrow, mourning dove, and scrub jay, were all noted in small numbers.

Transect #12 (mixed brush) exhibited the second lowest species diversity index (H' = 1.254). The five species recorded on this transect, green-tailed towhee, Brewer's sparrow, vesper sparrow, MacGillivray's warbler, and blue-gray gnatcatcher are all common breeding species of the brushland (Davis, 1969).

Fourteen species were recorded along Transect #13 (Douglas fir). The most abundant species were the gray-headed junco and ruby-crowned kinglet. All other species were tallied in low numbers. The olive-sided flycatcher was recorded for the first time in the study area along this transect during June, 1976 sampling. This species is a common summer resident of Colorado's coniferous forests (Bailey and Niedrach, 1965).

Eleven species were recorded along Transect #14 (aspen). The most abundant species were the ruby-crowned kinglet, hermit thrush, gray-headed junco, and black-capped chickadee. These species are all common breeding species of montane forests (Bailey and Niedrach, 1965).

Transect #15 (riparian) exhibited the highest avian density of all 15 transects sampled in June, 1976. Many species were recorded in large numbers. Of the 17 species recorded, the numerically dominant species were Brewer's sparrow, red-winged blackbird, blue-gray gnatcatcher, and song sparrow. The diversity index for this transect was 2.325.

Qualitative surveys were conducted in conjunction with the strip transects during June 25-29, 1976- Twenty songbird species were recorded during these surveys, all of which were recorded on strip transects conducted at the same time.

During the 1976 breeding season investigations, two songbird nests were identified on the study area. A pair of barn swallows and a pair of Say's phoebes both nested in a cabin located along the Right Fork of Stake Springs Draw.

2.3.7.2 Upland Gamebirds

A sage grouse brood survey was conducted July 21-22, 1976. One adult male sage grouse was observed on Landing Strip Ridge during the second day of the survey.

Numerous opportunistic sightings of sage grouse were made throughout the summer. All birds were observed in four areas: (1) 2 adults were seen in mixed brush on Landing Strip Ridge Road approximately 3 miles northeast of Cathedral Bluffs; (2) 2 groups of 7 adults and 1 adult and 2 juveniles were seen in sagebrush and mixed brush vegetation types, respectively, on Bar-D Mesa; (3) 3 sightings of 1 adult and 3 juveniles, 2 adults and 2 adults were made on Airplane Ridge between 1 1/2 and 2 miles northeast of Cathedral Bluffs; and (4) 8 different sightings of adults and juveniles were recorded in the mixed brush, sage/mixed brush and upland meadow and bald/mixed brush vegetation types all along the Cathedral Bluffs road in the study area.

The areas in which booming blue grouse males were recorded during the May, 1976 blue grouse survey were revisited on August 10 and 11, 1976. Seven adult males, four adult females, and four juveniles were recorded.

Opportunistic sightings of blue grouse occurred throughout the summer. All sightings occurred in the mixed brush, mixed brush/bald, mixed brush/aspen, bald and sagebrush vegetation types along Cathedral Bluffs.

The mourning dove is the most frequently encountered upland gamebird in the study area. It was recorded in every dominant vegetation type in the lower elevations of the study area during the June, 1976 songbird quantitative and qualitative censuses.

2.3.7.3 Waterfowl

Waterfowl surveys were conducted at Stake Springs impoundment on June 25-28, 1976 and August 10-13, 1976. During June waterfowl counts the common snipe, sora, American coot, green-winged teal, Wilson's phalarope, cinnamon teal and killdeer were recorded in small numbers at the impoundment. Sora, American coot, Wilson's phalarope and cinnamon teal were also noted on the impoundment during opportunistic sightings on June 25 and 26, 1976.

The cinnamon teal, sora, and spotted sandpiper were the only species recorded during the waterfowl surveys conducted in August, 1976. The fewer numbers of individuals and low species diversity noted on the impoundment during August in contrast to June is probably in part due to the secretive nature of the male waterfowl during their fall molt and the dispersion of many family flocks away from the nesting grounds prior to migration.

2.3.7.4 Raptors

An aerial raptor survey was conducted on June 10, 1976 but had to be aborted due to high winds. It was repeated June 21, 1976.

Eighteen individuals representing six raptor species were recorded. Three golden eagles, 1 red-tailed hawk, 1 sharp-shinned hawk, 2 prairie falcons, 3 American kestrels, and 8 common ravens were encountered.

The last aerial raptor survey of RBOSP's baseline studies was conducted on August 9, 1976. Two marsh hawks were the only raptors recorded during this survey.

A ground raptor nest search was conducted June 13-16, 1976. Nine nests were located during this survey. Eight of these nests were inactive. One active golden eagle eyrie with two 9-10 week old nestlings was located on Cathedral Bluffs. An active sharp-shinned hawk nest containing at least one nestling was observed in the pinyon-juniper woodland during the July invertebrate sampling trip. This was the first sharp-shinned hawk nest located on the Tract C-a study area.

Nine raptor species were opportunistically encountered during the 1976 breeding season on Tract C-a and environs. The most abundant species encountered were the common raven, American kestrel and red-tailed hawk. Other species observed were the golden eagle, prairie falcon, marsh hawk, sharp-shinned hawk, great horned owl, and Swainson's hawk. Swainson's hawks were recorded on several occasions throughout the summer in the bottomland meadow habitat at the confluence of Corral Gulch and Yellow Creek. This is an uncommon nesting species in western Colorado (Davis, 1969).

LITERATURE CITED

Bailey, A.W. and R.J. Neidrach. 1965. Birds of Colorado. Volume 1 and 2. Denver Museum of Natural History. Denver, Colorado. 895 pages.

Davis, W.A. 1969. Birds in western Colorado. Colorado Field Ornithologist, Boulder, Colorado.

2.3.8 Reptiles and Amphibians

Five permanent and five non-permanent reptile transects were sampled during June 24-29, 1976 and during August 10-12, 1976. The results of these two sampling trips are summarized in Table 2.3-8.

Lizards were more numerous in the more open vegetation types such as south slope pinyon-juniper and nearly bare, rocky, south slopes. This reflects a typical behavior pattern of lizards in that they seem to prefer areas with many basking locations (Stebbins, 1954). In addition to lacking adequate basking sites, the denser vegetation types (e.g., mixed brush, bottomland sagebrush, aspen) also

Table 2.3-8. Summary of reptile data collected on permanent and non-permanent transects in June and August, 1976 for RBOSP

Transect	Type	Vegetation	Species Observed	Number of Individuals			Age Class	
				Male	Female	Unknown	Adult	Juvenile
			JUNE 1976					
1	P[1/]	Greasewood-sagebrush	*Sceloporus graciosus*	0	2	0	2	0
2	P	South Slope Pinyon-Juniper	*Sceloporus graciosus*	2	5	1	7	1
			Phrynosoma douglassi	0	1	0	1	0
3	P	North Slope Pinyon-Juniper	*Sceloporus graciosus*	1	2	1	2	2
4	P	Sagebrush	None	0	0	0	0	0
5	P	Mixed Brush	None	0	0	0	0	0
16	NP[2/]	Shadscale	*Sceloporus graciosus*	2	2	0	4	0
17	NP	Riparian	None	0	0	0	0	0
18	NP	Rocky South Slope	*Urosaurus ornatus*	7	5	23	35	0
			Sceloporus graciosus	5	2	2	8	1
			Sceloporus undulatus	0	2	0	2	0
19	NP	Upland Meadow	None	0	0	0	0	0
20	NP	Aspen	None	0	0	0	0	0
			AUGUST 1976					
1	P	Greasewood-Sagebrush	None	0	0	0	0	0
2	P	South Slope Pinyon-Juniper	*Sceloporus graciosus*	1	2	2	5	0
3	P	North Slope Pinyon-Juniper	*Sceloporus graciosus*	1	3	0	2	2
4	P	Sagebrush	*Sceloporus graciosus*	1	0	0	1	0
5	P	Mixed Brush	None	0	0	0	0	0
21	NP	Pinyon-Juniper (Ridgetop)	None	0	0	0	0	0

Table 2.3-8. (Continued)

				Number of Individuals			Age Class	
Transect	Type	Vegetation	Species Observed	Male	Female	Unknown	Adult	Juvenile
22	NP	Douglas Fir	None	0	0	0	0	0
23	NP	South Slope Pinyon-Juniper	*Sceloporus graciosus*	0	2	4	4	2
24	NP	Sagebrush (Bottom)	None	0	0	0	0	0
25	NP	Rocky Cliffs	*Sceloporus graciosus*	1	2	1	4	0
			Urosaurus ornatus	4	2	1	7	0
			Sceloporus undulatus	0	2	4	6	0

[1] P = Permanent Transect

[2] NP = Non-permanent Transect

have severely restricted observer visibility. It is likely that the former phenomenon is more important in accounting for low sampling success in the denser vegetation types, however.

Four reptile species were recorded during each of the two sampling trips. Exposed rocky slopes with sparse pinyon, juniper, and sagebrush displayed the greatest diversity and numbers of lizards. An especially large number (35) of tree lizards was observed in June along a rocky south slope traversed by Transect #18. During both sampling periods, temperatures were in the mid to lower 20's C (slightly warmer in August), and cloud cover was variable but generally less than 50%. Winds were less than 10 mph. These meteorological conditions suggest no weather interference with herpetofauna activity during the sampling period.

Amphibian breeding site visits were conducted at ponds in Corral Gulch, Stake Springs Draw, and Duck Creek on June 28, 1976 and in Corral Gulch and Stake Springs ponds only on June 29, 1976. Chorus frogs and mountain spadefoots were heard calling on the first night but only the chorus frog was heard calling the second night. As discussed above for reptile sampling, the weather was seasonable, with essentially no cloud cover and cool evening temperatures.

LITERATURE CITED

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2.3.9 Terrestrial Invertebrates

Samples taken during May, 1976 were identified and enumerated during the period June through August 31, 1976. Identification and enumeration of samples taken in July, 1976 are in progress.

May, 1976 results from greasewood-sagebrush (Site 1) show a substantial increase in total invertebrate captures in both the surface and subsurface dwelling invertebrate groups, relative to samples taken in May, 1975. The numerically predominant groups also changed from harvestmen (Phalangida) and several spider (Araneida) and beetle (Coleoptera) families in May, 1975 to mites (Acari), springtails (Collembola) and bookline (Psocoptera) in May, 1976.

Herbaceous sweep samples from the vegetation in May, 1975 and May, 1976 yielded comparable results as did the more specific aerial sweep and beating samples of sagebrush for both years. Total captures of invertebrates vacuumed from rabbitbrush were greater by a factor of twenty in May, 1976 than for May, 1975 yielding an average estimated densityof greater than 15,000 invertebrates per cubic meter of vegetation for May, 1976. The numerically dominant group in both years was thrips (Thysanoptera).

Sampling of active flying insects indicated that captures in May, 1975 were ten times greater than in May, 1976. There was an overall decrease in captures for all major families in May, 1976 with the largest decrease in the number of non-biting midges (Chironomidae) Changes in physical conditions such as the availability of free standing water from May, 1975 to May, 1976 may partially explain the decline in numbers since this family has aquatic larvae.

At the pinyon-juniper, south slope site (Site 2), litter and ground dwelling invertebrate captures were substantially higher in May, 1976 than in May, 1975 although the numerically predominant groups, springtails (Collembola) and mites (Acari), were essentially the same both years.

A substantial decrease in total captures was recorded for active flying insects captured in Malaise traps in 1976 relative to 1975. A drop in totals for most groups and almost complete absence of Chironomidae accounted for much of the reduction in total numbers of flying insects captured.

The total number of captures from vacuuming sagebrush, and aerial sweeps and beating of pinyon and juniper, were comparable for May, 1975 and May, 1976. The density of invertebrates per cubic meter of sagebrush was greater in May, 1976 than in May, 1975. Larvae of Tortricoidea moths were one of the most abundant groups captured during both sampling periods. Abundant invertebrate groups captured by sweeping and beating of pinyon and juniper were similar for May of 1975 and 1976.

Total captures of invertebrates from sweeping of the herbaceous stratum of the pinyon-juniper south slope habitat were greater in May, 1975 than in May, 1976.

At the pinyon-juniper, north slope site (Site 3) total invertebrate captures from pitfalls sampled in May, 1975 and May, 1976 were nearly identical. Collembola was the dominant group numerically during both sampling periods. Captures from the litter were substnatially greater in May, 1976 due primarily to the increased number of Collembola in the samples. There was a lack of beetles (Coleoptera) observed and collected in both pitfall and litter samples in May, 1976 compared to relatively large capture totals in May, 1975.

Results from aerial sweeping and beating of pinyon and juniper, and vacuuming of sagebrush, were essentially the same for total captures in May, 1975 and May, 1976 although differences existed in the numerically dominant groups. Plant bugs (Miridae) were numerically important on juniper in both periods, while samples from pinyon yielded nearly the same dominant groups each period with small changes in capture totalsfrom May, 1975 to May, 1976. Vacuuming samples yielded substantially different estimates of invertebrate density, but the numerically dominant group was the same each period.

Only four insects were captured in the May, 1976 herbaceous sweep sample as compared to 29 in May, 1975. Leafhoppers (Cicadellidae) were the only group captured during both periods.

As at other sampling sites, active flying insect captures were reduced substantially in May, 1976. Much of this reduction results from the absence in samples of those dipteran families such as Chironomidae, Mycetophilidae, and Sciaridae whose larval stages are dependent on relatively moist conditions. Such conditions did not exist in May, 1976.

At the upland sagebrush site (Site 4) greater numbers of ground dwelling and litter dwelling invertebrates were present in May of 1975 than in May, 1976. Much of the decrease in numbers demonstrated in May, 1976 was due to the relative lack of Collembola active on the ground surface at this site. Total captures from general herbaceous sweep samples and vacuuming of sagebrush were essentially the same in May, 1975 and May, 1976. In May, 1975, a variety of groups were abundant including Formicidae, Delphacidae, Coccinellidae and a variety of Lepidoptera larvae. Captures from Malaise traps decreased from over 4000 in May, 1975 to only 300 in May, 1976. As in the other habitat types, much of this reduction was due to the reductions in families whose larval stages are moisture dependent.

At the mixed brush site (Site 5) pitfall and litter captures were substantially higher in May, 1976 than in May, 1975. In both sampling types, the increase in captures this year was due primarily to an increase in Collembola. Total captures from general herbaceous sweep samples and vacuuming of serviceberry and snowberry were essentially the same both years, although the numerically dominant groups have changed somewhat. In May, 1975 weevils (Curculionidae) were the most abundant group captured from both plant species. In May, 1976, mites (Acari) and thrips (Thysanoptera) and ants (Formicidae) were the dominant groups taken from serviceberry and snowberry, respectively.

Captures from Malaise traps decreased from over 6500 in May, 1975 to only 319 in 1976. As at other vegetation types much of this reduction was due to reductions in total numbers of families whose larval stages are moisture dependent.

2.3.10 Domestic Livestock

Domestic livestock data were collected concurrently with large mammal data during flights on June 10 and August 9, 1976. Five hundred forty-three cattle were observed during the June survey and 163 cattle were observed during the August survey. Cattle observed in June were located mainly on 84 Mesa and in the bottomlands of Stake Springs Draw and Ryan Gulch. Most of the cattle observed during August were scattered throughout the higher elevations west of Tract C-a.

2.4 Aquatic Studies

The overall objective for the Aquatic Baseline Data Accumulation Program is to characterize the existing aquatic communities on and in the vicinity of Tract C-a. These studies will inventory aquatic habitats which may be affected by oil shale development.

In order to fulfill these ojectives, 35 sampling stations have been selected to represent the aquatic habitats present. Emphasis has been placed on Yellow Creek and the White River which are premanently flowing streams. Sampling periods discussed herein include April 1976, May - June 1976, and July - August 1976. The condition (dry or flowing) of each station during this period and dates on which aquatic samples were taken during the May - June and July - August 1976 periods are shown in Table 2.4-1. Physical, chemical, and biological measurements are taken concurrently at each sampling site.

2.4.1 Physical and Chemical Characteristics

During the May - June 1976 sampling period, Stations 10 - 12, 16, 24, 30, 33, and 34 were dry or inaccessible due to the high flows in the White River.

A summary of selected parameters for the Yellow Creek and White River stations for the May - June 1976 period is presented below:

May - June 1976

Parameter	Yellow Creek	White River
Specific conductance (µmhos)	2,600 - 4,200	480 - 1,000
pH	8.0- 9.0	7.9 - 8.3
Alkalinity, total ($CaCO_3$mg/l)	796 - 1,226	155 - 321
Chloride (mg/l)	27 - 162	7 - 22
Sulfate (mg/l)	183 - 294	27 - 36
Dissolved solids (mg/l)	2,069 - 2,781	318 - 483
Turbidity (JTU)	10 - 23	11 - 325
Dissolved oxygen (mg/l)	6.3- 11.6	8.0 - 8.6
Temperature (^{0}C)	14 - 25	14 - 19

During the July - August 1976 sampling period, Stations 6, 10 - 12, and 15 - 18 were dry. A summary of selected parameters for the Yellow Creek and White River stations from the July - August sampling is presented below:

Table 2.4-1. Dates of Sampling for RBOSP Aquatic Baseline Studies, May - June and July - August, 1976.

	May - June 1976		July - August 1976	
Station	Date Sampled	Flow Condition	Date Sampled	Flow Condition
1	6- 4-76	Flowing	7-15-76	Flowing
2	6- 4-76	Flowing	7-15-76	Flowing
3	6- 2-76	Flowing	7-20-76	Flowing
4	6- 3-76	Flowing	7-19-76	Flowing
5	5-24-76	Flowing	7-27-76	Flowing
6	5-24-76	Flowing	7-14-76	Dry
7	6- 3-76	Flowing	7-19-76	Flowing
8	5-24-76	Flowing	7-14-76	Flowing
9	6- 3-76	Flowing	7-19-76	Flowing
10	6- 3-76	Dry	7-20-76	Dry
11	6- 3-76	Dry	7-20-76	Dry
12	6- 3-76	Dry	7-20-76	Dry
13	5-25-76	Flowing	7-22-76	Flowing
14	6- 1-76	Flowing	7-22-76	Flowing
15	6- 1-76	Flowing	6-14-76	Dry
16	5-24-76	Dry	7-15-76	Dry
17	6- 1-76	Flowing	7-14-76	Dry
18	6- 1-76	Flowing	7-14-76	Dry
19	5-24-76	Flowing	7-27-76	Flowing
20	6-24-76	Flowing	7-23-76	Flowing
21	6-24-76	Flowing	7-23-76	Flowing
22	6-23-76	Flowing	7-23-76	Flowing
23	6-25-76	Flowing	8- 4-76	Flowing
24	6-21-76	Inac. (High Flows)	8- 7-76	Flowing
25	6-21-76	Flowing	8- 7-76	Flowing
26	6-21-76	Flowing	8- 7-76	Flowing
27	6-22-76	Flowing	8- 2-76	Flowing
28	6-22-76	Flowing	8- 2-76	Flowing
29	6-22-76	Flowing	8- 2-76	Flowing
30	6-27-76	Inac. (High Flows)	8- 6-76	Flowing
31	6-27-76	Flowing	8- 6-76	Flowing
32	6-27-76	Flowing	8- 6-76	Flowing
33	6-23-76	Inac. (High Flows)	8- 3-76	Flowing
34	6-23-76	Flowing	8- 3-76	Flowing
35	6-23-76	Flowing	8- 3-76	Flowing

Abbreviation:

Inac. = Inaccessible

July - August 1976

Parameter	Yellow Creek	White River
Specific conductance (µmhos)	2,800 -4,500	850 -3,500
pH	8.0 - 8.0	7.8 - 8.1
Alkalinity, total ($CaCO_3$mg/l)	754 -1,664	246 - 328
Chloride (mg/l)	29 - 179	32 - 42
Sulfate (mg/l)	149 - 293	58 - 70
Dissolved solids (mg/l)	1,955 -2,703	521 - 701
Turbidity (JTU)	3 - 30	35 - 365
Dissolved oxygen (mg/l)	8.6 - 12.9	7.3 - 8.9
Temperature (^{o}C)	19 - 31	17 - 22

Comparison of the physical and chemical data for the May - June 1976 sampling period with that of May - June 1975 indicates that the range of water temperatures was similar in Yellow Creek but higher (2 - 6^{o}C) in the White River in 1976. Turbidities were generally higher in both Yellow Creek and the White River in 1976 than in 1975 (3 - 7 JTU in Yellow Creek and 29 - 77 JTU in White River). The concentrations of dissolved solids were also higher in 1976 than in 1975 (2,100 - 2,600 mg/l in Yellow Creek; 192 - 269 mg/l in White River) in both Yellow Creek and the White River, as was the range of specific conductance (1,900 - 3,600 µmhos in Yellow Creek in 1975; 250 - 450 µmhos in White River in 1975). These generally higher concentrations of constituents in Yellow Creek and the White River in 1976 are likely related to the occurrence of heavy showers and associated runoff during the 1976 sampling.

Comparison of the physical and chemical data for the July - August 1976 sampling period with that of July - August 1975 indicates that the range of water temperatures was higher in Yellow Creek (16 - 22 ^{o}C in 1975) in 1976 but very similar in the White River (18 - 21 ^{o}C in 1975). In Yellow Creek, turbidities were similar during July - August 1975 (7 - 25 JTU) and 1976, whereas turbidities in the White River were higher during July - August 1976 than during the same period in 1975 (10 - 35 JTU). The concentrations of dissolved solids were generally higher in 1976 in both Yellow Creek and the White River than they were in 1975 (1,920 - 2,580 mg/l in Yellow Creek; 365 - 417 mg/l in White River); the specific conductance was also higher in both Yellow Creek and the White River in 1976 than in 1975 (2,600 - 3,900 µmhos in Yellow Creek; 625 - 1,250 µmhos in White River). The generally higher turbidities, conductivity, and levels of dissolved solids in the White River during the 1976 sampling period were likely related to rain showers and to road construction (Piceance Creek Bridge) several miles upstream of the sampling area.

2.4.2 Phytoplankton

A total of 118 algal taxa was observed in the April phytoplankton collection.

During April, the most abundant phytoplankton taxa at the headwater stations were the diatoms *Navicula pelliculosa*, *Achnanthes minutissima*, and *Surirella ovata* and the chrysophyte *Chrysidiastrum ocellatum*. At the tract stations, the most abundant taxa included *Navicula pelliculosa*, *Chrysidiastrum ocellatum*, and unidentified flagellates. In Yellow Creek, the most abundant phytoplankton taxa were *Synedra amphicephala*, *Nitzschia capitellata*, *Surirella ovata*, and unidentified flagellates, whereas in the White River, the most abundant taxa were *Navicula viridula*, *Gomphonema olivaceum*, *Nitzschia capitellata*, and *Surirella ovata*.

A total of 122 phytoplankton taxa was observed in the May - June phytoplankton collection.

During the May - June period, the most abundant algal taxa in the phytoplankton of the headwater stations were the diatoms *Achnanthes minutissima*, *Navicula pelliculosa*, and *Nitzschia capitellata* and the chrysophyte *Chrysidiastrum ocellatum*. At the tract stations, the most abundant taxa were the diatoms *Achnanthes minutissima*, *Navicula pelliculosa*, *Navicula cryptocephala*, the chrysophyte *Chrysidiastrum ocellatum*, the green algal *Quadrigula lacustris*, and unidentified microflagellates. In Yellow Creek, the most abundant taxa were the diatom *Cyclotella meneghiniana* and unidentified microflagellates, whereas in the White River, the most abundant taxa were the diatoms *Navicula cryptocephala*, *Navicula pelliculosa*, *Navicula viridula*, *Gomphonema olivaceum*, and *Cyclotella meneghiniana*.

Comparison of phytoplankton data from the two sampling periods with data collected during similar periods in 1975 indicates that diatoms were generally the most abundant algal taxa in the phytoplankton of the study area during both years. Phytoplankton abundance was generally low throughout the study area and phytoplankton constitutes a secondary source of primary production (periphytic algae is the primary source) in waters of the study area.

2.4.3 Zooplankton

A total of 73 zooplankton taxa was observed in the May - June 1976 collections.

Zooplankton diversities and densities which occurred during the May - June 1976 sampling were very similar to those of May - June 1975. *Centropyxis* spp., Notholca spp., and bdelloid rotifers dominated the zooplankton at the headwater and tract stations. Nauplii, *Bryocamptus hiemalis*, and ostracods were the most frequently occurring Crustacea. The Yellow Creek stations and Station 14 were characterized by high rotifer diversities with one or two species exhibiting very high densities. *Notholca acuminata* dominated the zooplankton at Station 14 and 19, and *Colurella adriatica* and *Lepadella patella* were the dominant taxa at the lower stations (20 - 22).

In the White River, the zooplankton assemblage was typified by a high diversity of organisms, with no dominant taxa. Because flow in the White River was near its peak, it is likely that this diversity resulted from greater inflow from the numerous tributaries upstream.

2.4.4 Periphyton

A total of 99 algal taxa was observed in the periphyton during the May - June period.

During May - June 1976, the most abundant algal taxa in the periphyton of the headwater stations were the diatoms *Achnanthes minutissima* and *Gomphonema intricatum* and the chrysophyte *Bicoeca lacustris*. In Yellow Creek, the dominant taxa were the diatoms *Achnanthes minutissima*, *Navicula pelliculosa*, *Nitzschia frustulum*, and *Cyclotella meneghiniana*, whereas in the White River, the dominant taxa included the blue-greens *Calothrix* spp. and *Lyngbya* spp. and the diatoms *Navicula cryptocephala*, *Navicula tripunctata*, *Amphora ovalis* var. *pediculus*, *Nitzschia dissipata*, *Nitzschia frustulum*, and *Achnanthes minutissima*.

The most abundant algal taxa collected from artificial substrates in Yellow Creek were *Achnanthes minutissima*, *Cyclotella meneghiniana*, *Nitzschia frustulum*, and *Fragilaria vaucheriae*. In the White River, *Cocconeis pediculus* and *Cocconeis placentula* were very abundant on artificial substrates.

During May - June 1976, as in May - June 1975, diatoms were the dominant algal taxa in the periphyton although there were some differences in the species composition of the dominant taxa. In waters of the study area, the periphytic algae generally constitute the major source of primary production.

2.4.5 Benthos

Benthos taxa observed to date (laboratory analysis of Chironomidae and Oligochaeta were completed too late for inclusion) from the May - June 1976 sampling are listed in Table 2.4-2.

Preliminary results of analysis of the May - June 1976 samples indicate that the most abundant benthic taxa at the headwater stations included Oligochaeta, Chironomidae, Baetidae, Hydroptilidae, and *Nemoura* sp. At the tract stations, the most abundant taxa included Chironomidae, Simuliidae, Oligochaeta, and Ceratopogonidae. In Yellow Creek, the

Table 2.4-2. Macroinvertebrate taxa observed during RBOSP Aquatic Baseline Studies, May - June 1976.

- Plathelminthes
  - Turbellaria
    - Tricladida

- Nematoda

- Mollusca
  - Gastropoda
    - Basommatophora
      - Lymnaeidae
        - *Lymnaea* sp. Lamark

- Annelida
  - Hirudinea
    - Rhynchobdellida
      - Glossiphoniidae
        - *Helobdella stagnalis* (Linnaeus)
  - Oligochaeta

- Arthropoda
  - Arachnoidea
    - Acari
  - Crustacea
    - Amphipoda
      - Talitridae
        - *Hyalella azteca*
  - Insecta
    - Collembola
    - Ephemeroptera
      - Baetidae
        - *Baetis* sp. Leach
        - *Dactylobaetis* sp. Traver and Edmunds
      - Heptageniidae
        - *Epeorus* sp. Eaton
        - *Epeorus longimannis* (Eaton)
        - *Heptagenia* sp. Walsh
        - *Rhithrogena* sp. Eaton
      - Leptophlebiidae
        - *Paraleptophlebia* sp. Lestage
      - Ephemerellidae
        - *Ephemerella* sp. Walsh
      - Tricorythidae
        - *Tricorythodes* sp. Ulmer

    - Odonata
      - Coenagrionidae
        - *Amphiagrion* sp. Celys

Table 2.4-2. (Continued)

    - Gomphidae
  - Plecoptera
    - Nemouridae
      - *Nemoura* sp. Pictet
    - Perlodidae
      - *Isogenus* sp. Newman
      - *Isoperla* sp. Banks
  - Coleoptera
    - Dytiscidae
      - *Agabus* sp. Leach
      - *Deronectes* sp. Sharp
    - Hydrophilidae
      - *Berosus* sp. Leach
      - *Cymbiodyta* sp. Bedel
    - Elmidae
      - *Optioservus* sp. Sanderson
  - Trichoptera
    - Hydropsychidae
      - *Cheumatopsyche* sp. Wallengren
      - *Hydropsyche* sp. Pictet
    - Hydroptilidae
    - Limnephilidae
      - *Hesperophylax* sp. Banks
      - *Limnephilus* sp. Leach
    - Leptoceridae
      - *Oecetis* sp. McLanchlan
    - Brachycentridae
      - *Brachycentrus* sp. Curtis
  - Lepidoptera
    - Pyralidae
  - Diptera
    - Tipulidae
      - *Ormosia* sp. Rondani
      - *Dicranota* sp. Zetterstedt
      - *Limnophila* sp. Macquart
      - *Holorusia* sp. Loew
    - Psychodidae
      - *Pericoma* sp. Walker
    - Dixidae
      - *Dixa* sp. Meigen
    - Ceratopogonidae
    - Chironomidae
    - Simuliidae
      - *Simulium* sp. Latreille
    - Stratiomyidae
      - *Euparyphus* sp. Gerstaecker

Table 2.4-2. (Continued)

  - *Stratiomys* sp. Geoffrey
- Tabanidae
  - *Chrysops* sp. Meigen
- Rhagionidae
  - *Atherix variegata* Walker
- Empididae
- Ephydridae
- Muscidae
- Anthyomiidae
  - *Limnophora aequifrons* Stein
  - *Limnophora discreta* Stein

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most abundant taxa were Oligochaeta, Chironomidae, Simuliidae, and Simulium sp. The most abundant taxa in the White River were Chironomidae, Simuliidae, Baetidae, Oligochaeta, and Ephemerella sp.

2.4.6 Sediment Chemistry

A summary of results for selected parameters for May - June and July - August 1976 is presented below. Concentrations of the parameters were generally similar to those observed during corresponding sampling periods in 1975.

May - June 1976

Parameter (μg/g)	White River	Yellow Creek
Aluminum	3,800-11,000	6,200-7,400
Arsenic	3- 6	4- 9
Lead	4- 13	5- 9
Zinc	26- 66	29- 38

July - August 1976

Parameter (μg/g)	White River	Yellow Creek
Aluminum	3,800-11,900	4,600-12,700
Arsenic	4- 10	3- 7
Lead	4- 16	4- 15
Zinc	25- 59	24- 72

2.4.7 Macrophytes

During the May - June 1976 sampling period, aquatic macrophytes were observed at Stations 2, 4, 5, 14, and 19. At Station 2, watercress, Rorippa nasturtium-aquaticum was observed in scattered abundance; at Stations 4 and 5, watercress was presented in very low abundance, whereas at Station 14, horned pondweed, Zannichellia palustris was present in scattered abundance. At Station 19, Chara kieneri was found in low abundance while Zannichellia palustris was present in rank abundance.

During the July 1976 sampling, aquatic macrophytes were observed at Stations 1, 2, 4, 5, 14, and 19. At Stations 1, 2, and 4, the abundance of watercress, Rorippa nasturtium-aquaticum was low. At Station 5, Ranunculus cymbolaria was observed in scattered abundance, along with scattered Chara kieneri, Zannichella palustris, and Typha sp. At Station 14, the abundance of Zannichellia palustris was rank, whereas at Station 19, Zannichellia palustris was present in scattered abundance and sedges were present in rank abundance.

2.4.8 Fish

A summary of fish data from the May - June 1976 sampling is presented in Table 2.4-3. During the June 1976 sampling, a total of 171 fish representing six species was captured in Yellow Creek at the White River. The most abundant species was speckled dace, and no game fish species were observed. High water and turbidity in the White River reduced the efficiency of the fishing efforts and precluded sampling at Stations 24, 30, 33, and 34. This compares with June 1975 when 463 fish, representing seven species, were captured. The most abundant species at this time was also dace.

2.4.9 Springs and Seepages

Approximate locations of springs and seepages on or near Tract C-a are shown on Figure 2.4-1. No additional springs or seepages have been observed since Progress Report 7.

2.4.10 Hydrology

The approximate stream velocities observed during May - June and July - August 1976 are presented in Table 2.4-4.

Table 2.4-3. List of fish species and numbers captured, White River and Lower Yellow Creek. RBOSP Aquatic Baseline Studies May - June 1976.

Common Name	Scientific Name	Number Captured
Flannelmouth sucker	*Catostomus latipinnis*	48
Bluehead sucker	*Catostomus discobolus*	9
Roundtail chub	*Gila robusta*	3
Speckled dace	*Rhinichthys osculus*	90
Fathead minnow	*Pimephales promelas*	1
Mottled sculpin	*Cottus bairdi*	20

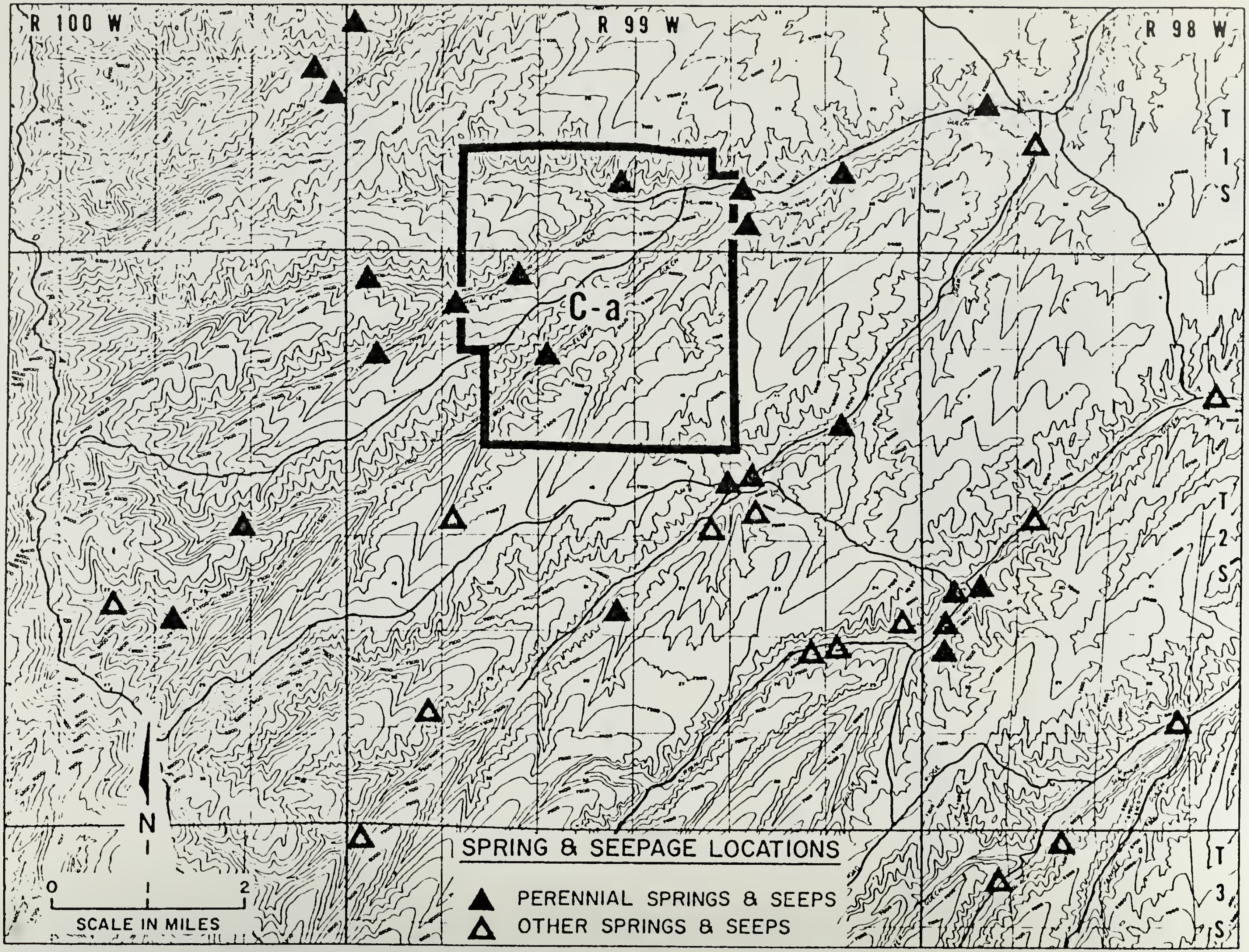

Figure 2.4-1. Spring and Seepage Locations

Table 2.4-4. Stream velocity during RBOSP Aquatic Baseline Studies, May - June and July - August, 1976.[1] (Results are expressed in feet per second and, where appropriate, are given for bank side (s) and point of maximum flow (m).)

Station	Velocity, May - June			Velocity, July - August		
	s	m	s	s	m	s
1		2.1			0.5	
2		2.7			1.1	
3		0.3			0.5	
4		0.8			0.4	
5		0.5			0.9	
6		1.3			Dry	
7		1.1			0.3	
8		1.5			1.8	
9		0.8			0.3	
13		2.1			2.1	
14		1.1			1.5	
15		0.7			Dry	
17		0.8			Dry	
18		0.6			Dry	
19		1.8			1.9	
20		1.8			1.1	
21		0.7			0.6	
22		1.6			1.0	
23		5.8		2.3;	2.7;	2.4
24		Inac.		1.7;	1.0;	0.7
25	2.1;	3.0;	2.9	1.8;	2.0;	1.6
26	2.1;	2.1;	2.1	0.9;	1.6;	2.7
27	0.3;	1.4;	0.7	0.7;	0.8;	0.4
28	1.5;	1.6;	1.2	0.9;	1.0;	1.2
29	2.1;	3.1;	3.7	1.2;	3.2;	2.5
30		Inac.		2.3	2.1;	1.9
31		4.2		2.1;	2.3;	2.1
32		2.6		1.3;	1.1;	2.5
33		Inac.		1.6;	1.9;	2.4
34		Inac.		2.0;	4.2;	2.7
35		2.8		2.4;	4.0;	2.9

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[1] Stations 10 - 12 and 16 were dry during both sampling periods.

Abbreviation:
Inac. = Inaccessible

2.5 Other Environmental Programs

2.5.1 Soil Survey and Productivity Assessment Studies

2.5.1.1 Objectives (See Progress Report 7)

2.5.1.2 Methods (See Progress Report 7)

2.5.1.3 Results and Discussion

All field work for the soils program has been completed. Chemical and physical analyses, with the exception of ammonium analysis, has also been completed. The results of the analyses are currently being punched on computer cards in preparation for detailed statistical analyses. Current plans envision completion of this program by the end of the calendar year.

2.5.2 Archaeological Survey

The final report, which was released in May 1976, is still under review by state and federal agencies. Comments are being incorporated following a discussion with the reviewer. The cultural resource document includes archaeological, historical and paleontological sections.

2.5.3 Revegetation

2.5.3.1 1975 Revegetation Studies

Field studies estimating seedling emergence and survival on the 1975 revegetation plots have been completed. Data from these studies are being analyzed and the results will be reported by the end of the current year.

2.5.3.2 1976 Revegetation Studies

2.5.3.2.1 Objectives

The objectives of the 1976 RBOSP revegetation experimental program are:

1. To determine if the simulated artificial soil profile can inhibit upward capillary migration of salts from Tosco II processed shale.
2. To determine which plant species (when sown in a composite mixture on the simulated artificial soil profile) are best adapted to the environmental conditions existing on a south exposure on Tract C-a.
3. To determine if several mulches applied to the simulated artificial soil profile are effective in aiding establishment and survival of plant species and in reducing erosion.
4. To compare growth and survival of native shrubs that are sown directly or planted as tubelings on the simulated artificial soil profile.

2.5.3.2.2 Methods

The 1976 revegetation experiments will simulate the artificial soil profile described in the RBOSP Detailed Development Plan (1976) utilizing Tosco II processed shale. Seedbed preparation for the 1976 revegetation plot was initiated on 29 September. Surface soil, subsurface soil and fractured rock material were removed and stockpiled. The processed shale layer and crushed rock layer will be placed in the plot in October and the surface and subsurface soils replaced. Seedbed preparation will continue throughout October and early November; completion is expected by mid-November.

2.5.5 Trace Metals

Trace metals analysis is included in the soil survey and productivity program. Following conclusion of that program, the data will be analyzed in light of trace metal cycling in the system.

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Progress report sum
Tract C-a oil shale

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